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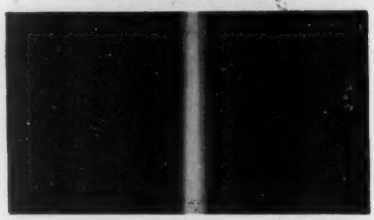

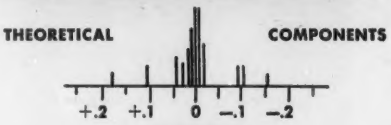

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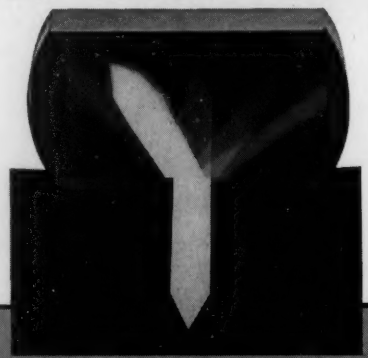

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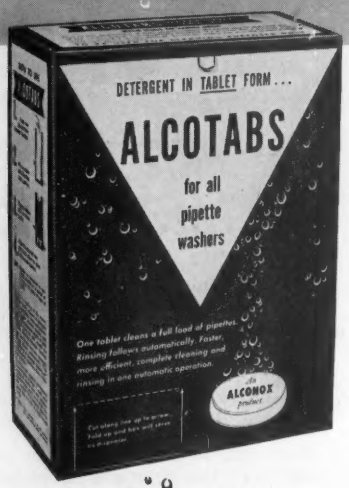
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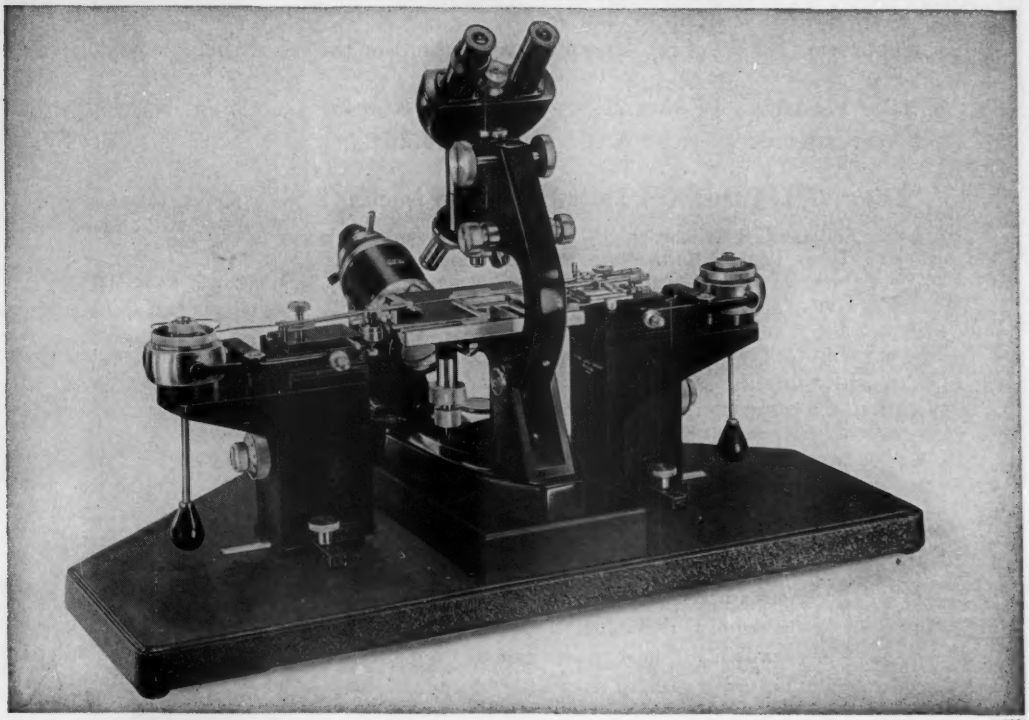

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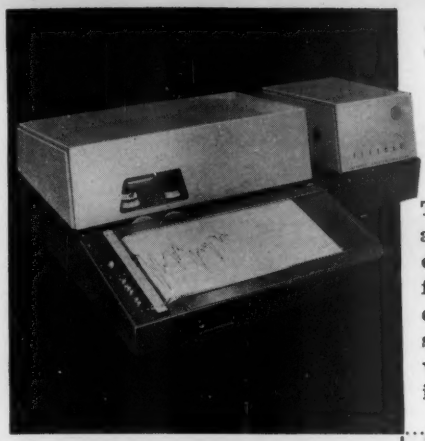

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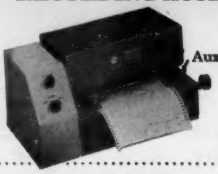

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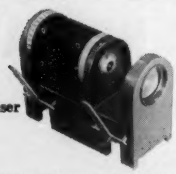

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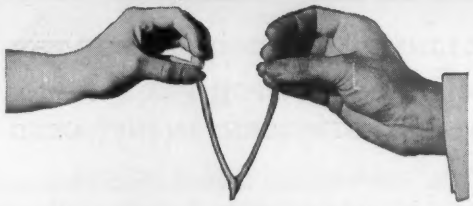

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When Scientists Disagree

The possibility that advances in science may have important social consequences is not new. Nor is it novel to find scientists in dispute about the meaning of a particular finding. But the recent striking increase in the first possibility has made the general public forcibly aware of the second. The result, in part, is a distrust of science arising from honest perplexity, for one may well ask who shall decide when scientists disagree. What the scientific enterprise needs is something better in the way of public relations, and the first point to make clear is that disagreement in science differs from the more familiar kinds of disagreement in an important respect.

In analyzing kinds of disagreement, it may be helpful to borrow the distinction between disagreements in *attitude* and disagreements in *belief* that was introduced by the contemporary American philosopher C. L. Stevenson. Suppose that a group of boys are considering playing a game. If one wants to play football and another baseball, this is a difference in attitude. But once football, say, is decided upon, and its rules accepted, then, if one boy claims that his opponent was offside and the latter says he was not, this is a difference in belief. A corollary of this distinction is that there is no logical connection between disagreements in attitude and disagreements in belief, although the two may be related as a matter of psychological fact. For example, if one of the boys wants to play baseball under the impression that it is spring, when in fact it is fall, his choice of game might change once his beliefs were corrected.

This is not to deny that the disputes usually encountered in the world are complex affairs. The point is that they are complex in a special way, for they involve differences both in attitude and in belief. For example, in a dispute between management and labor, the opposing parties may disagree about how much profit management is making—that is, in the facts of the case—as well as in their respective judgments about what constitutes a fair profit. Other examples of disputes that are complex in this special way include the differences between the Republicans and the Democrats, between the supporters of integration and of segregation, and between the faculty and the administration of a college.

In broadest outline, a scientific dispute differs from other disputes in that it involves only one kind of disagreement, a disagreement in belief. The attitude accepted by both parties is the scientific attitude, which finds that the way to answer a question, if it can be answered at all, is by an appeal to experiment—not by an appeal to force, to a vote, to authority, or to personal revelation. Further, the appeal to experiment must be conducted according to those principles that sometimes are collectively referred to as scientific method (see editorial in *Science* of 6 Sept. 1957).

To be sure, this account of the difference between scientific disagreement and the more familiar kinds of disagreement is oversimplified. Actually, in science there may be differences in attitude within the area of fundamental agreement. For example, in seeking an explanation for a particular behavioral disorder, one group may stress the subject's early training, another may emphasize organic disturbances. Nevertheless, when there is disagreement in belief, but agreement in scientific attitude, there is at least some assurance that the dispute is only temporary, because further application of the same method, a method accepted by both sides, may decide the question.—J. T.

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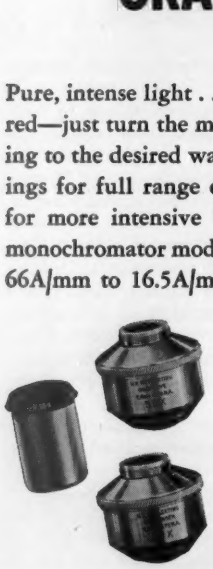

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Strontium-Calcium Movement from Soil to Man

C. L. Comar, R. Scott Russell, R. H. Wasserman

Attention has been focused on the possibility of hazards from contamination of the biosphere with strontium-90 produced and disseminated by atomic explosions. Other fission products have been considered less potentially hazardous because of lower fission yield, shorter half-life, or smaller incorporation into biological systems. Some heed, however, has been paid to possible hazards from radioisotopes of iodine (*1*) and cesium (*2*) and to the irradiation of the gastrointestinal tract from radioactive material that is ingested but not absorbed. The concern regarding strontium-90 arises because it moves similarly to calcium in food chains; it is well absorbed by plants, animals, and man; it is deposited and retained in bones; it is transmitted to milk and to the developing fetus; and it is known to cause bone tumors and is suspected of causing leukemia.

The incorporation of strontium-90 in the biosphere generally occurs as follows (*3*). Large weapons (megaton) deposit a large fraction of their strontium-90 in the stratosphere; this material slowly passes back into the troposphere with an average residence time in the stratosphere of about 10 years. Small weapons (kiloton) deposit their strontium-90 in the troposphere. The radioactivity in the troposphere, regardless of origin, is relatively quickly deposited on the surface of the earth, primarily by precipitation. Thus "kiloton" debris is deposited in restricted latitudes of origin, whereas "megaton" debris is widely distributed over the world. The strontium-90 falls out upon the surface of the soil and foliage. At any given time the strontium-90 available to the grazing animal can be classified as follows: (i) strontium-90 on the surface of foliage, (ii) strontium-90 incorporated in plant tissue by foliar absorption and mixed to a variable degree with plant calcium, and (iii) strontium-90 in plant tissue that had been mixed with the labile calcium of the soil and absorbed by the roots. The extent to which the strontium-90 is diluted with calcium will be least in source i and greatest in source iii. The relative contributions of these three sources will change with time; sources i and ii will become less significant when the contribution of new fallout is small compared with the previous contamination of the soil.

Two major areas of information are required to evaluate the potential hazard from the deposition of strontium-90 on the earth's surface: (i) What are and will be the levels of strontium-90 in the human population? (ii) At what levels of strontium-90 will damage occur? The second question does not fall within the scope of the present paper. In the evaluation of levels of strontium-90 in the biosphere, there is considerable advantage in dealing with strontium-90 to calcium ratios rather than with the absolute amounts of strontium-90 entering or leaving an organism. This is because exposure of the population occurs by way of strontium-90 contamination of dietary calcium, and strontium metabolism generally parallels and is interrelated with calcium metabolism; for example, the strontium-to-calcium ratios in the bones and tissues of animals are directly related to the ratio in the dietary intake. The level of contamination can easily be calculated from the strontium-90-to-calcium ratio when the calcium concentration in the tissue is known. The question to be considered therefore resolves itself as follows: What will be the strontium-90-to-calcium ratio in the human population as related to the strontium-90-to-calcium ratio of the dietary intake and as related to the strontium-90-to-calcium ratio of the vegetation, and how will this vary with the quantity of strontium-90 that is deposited on the ground surface? Under steady-state conditions, the relation between the strontium-90-to-calcium ratio of the body and the deposition in soil will be governed by the differential behavior of the two elements in a series of physical and physiological processes.

This article (*4*) reviews the findings related to the differential behavior of the two elements and is intended to serve as a basis for predicting the levels to be expected when the soil content and dietary intake can be estimated.

General Methods

Several modes of expression have been used to denote the comparative movement of strontium and calcium in biological systems (*5*, *6*). We propose to use the term *strontium-calcium observed ratio* (OR) to denote the over-all discrimination that is observed in the movement of the two elements from one phase to another.

$$OR_{sample-precursor} = \frac{Sr/Ca \text{ of sample}}{Sr/Ca \text{ of precursor}} \quad (1)$$

As is brought out in subsequent paragraphs, care must be taken in estimation of OR values; it is especially important that the strontium-to-calcium ratios as measured truly represent the ratio as actually available to the organism, and as actually derived from the measured precursor.

To denote the discrimination that is

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produced by a given physiological process, we propose to use the term *strontium-calcium discrimination factor* (DF). By definition:

$$OR = (DF_1)(DF_2)(DF_3) \ldots (DF_n) \quad (2)$$

The DF values are given specific names to denote the physiological process involved—for example, $DF_{urinary}$ designates the contribution to the over-all discrimination in the body that results from differential handling of the two elements by the kidney.

There are three types of procedures used to obtain information on the comparative metabolism of strontium and calcium.

1) *Analysis of natural strontium-calcium ratios in the precursor material and in the tissues deriving these minerals from the precursor* (*6*). A disadvantage is the difficult technique required for analysis of naturally occurring strontium. Another difficulty, particularly in soil-plant studies, is that the chemically determined values for strontium and calcium in the soil may not represent accurately the relative amounts available to the plant. In studies of man and animals by this method, it is necessary that the subjects have been exposed to a constant strontium-to-calcium ratio all their lives in order that reasonable interpretations may be made.

2) *Analysis and radioassay of tissue deriving its strontium and calcium from precursors with a constant ratio of added radiostrontium* (*strontium**) *to naturally occurring calcium* (*7*). This method requires feeding of the "spiked" nutrients (strontium-90 enriched) for a time long enough so that there is no interference from calcium stores laid down before the feeding began. Survey studies on the ratios of strontium-90 to calcium from fallout belong in this category. Difficulties of interpretation arise because (i) there may be preexisting stores of uncontaminated calcium in the organism; (ii) all the calcium of the intake may not become uniformly labeled with the strontium-90, since some of the strontium-90 that enters food chains will have been deposited aerially on the leaves, while part will have been absorbed from the soil; (iii) the discrimination may change with time—for example, from development *in utero* where there is a placental barrier, through the heavy milk-drinking stage where there is a lactation barrier, to the normal adult diet; (iv) the strontium-90-to-calcium ratio may also change with time as fallout occurs. In some instances, however, such as the analysis of foliage and of milk produced by animals grazing thereon, useful information is already available for certain discrimination processes.

3) *Radioassay of tissues from organisms receiving nutrient intakes of strontium* and calcium* in known and constant ratio* (*5*). This method (also called double labeling) is most convenient from an experimental standpoint, because the feeding time usually need not be more than a few days, since there is no interference from the preexisting calcium reservoir in the organism.

Strontium-Calcium Relationships in Plants

When plants are grown in soil, their content of strontium and calcium reflects the behavior of the two ions both before and after they cross the interface between the soil and the plant. It is therefore convenient to consider first the simpler systems of plants growing in inorganic solutions. By comparing the effects observed under these conditions with those occurring in plant-soil systems, information can be obtained on the behavior of the two ions in the complex physicochemical system of the soil.

The major part of the dietary strontium and calcium that man or animals receive from plants is contained in leaves; other aerial tissues make a much smaller contribution. It is known that strontium that has reached leaves is redistributed to other tissues to only a negligible extent (*8*); thus its movement through the plant is unidirectional from the root upward. Many studies in water culture have suggested that strontium and calcium are absorbed in a similar manner, and some results have encouraged the view that plants do not discriminate between the two ions. More detailed investigations, however, indicate that the interaction between strontium and calcium is more complex and that the OR may decrease progressively from the absorbing roots to the more remote aerial tissues (*9, 10*). Values for the aboveground parts of the majority of plants of major agricultural importance have been reported or can be calculated from published data. The range of values for the $OR_{\text{total plant shoot-outer medium}}$ appears to be in the order 0.7 to 1.3 (*9, 11, 12*). The majority of values are slightly below 1. Little information is available regarding storage organs—that is, potatoes, carrots, and so forth. Whereas only a small discrimination between the two ions appears to occur in the total shoot, the $OR_{\text{stem tissues-outer medium}}$ may reach values in excess of 5 (*12*).

These results are compatible with the view that the two ions interact in a sequence of exchange reactions during their passage from the outer medium to the shoots, strontium being retained to a somewhat greater extent at each step. Since plants possess no excretory mechanism, and since the major fraction of both ions entering the plants eventually reaches the leaves, no great discrimination is possible in these tissues. In the stem nodes, however, where a fraction of the upwardly moving divalent cations is temporarily retained, the separation of the two ions is subject to no such limitation. The high OR values that can occur in stems are attributed to this cause.

It is to be expected that the extent of discrimination between the two ions in such a system will vary with time and with the degree to which possible sites of retention are saturated. The possible extent of such changes has been shown by allowing barley plants to absorb strontium-89 and calcium-45 for 24 hours and examining them either immediately or after an interval of 56 days, no further tracers being applied. During this interval, upward movement from roots increased the strontium-89 content of the shoots by 40 percent, and the $OR_{\text{total shoot-outer medium}}$ rose from 0.85 to 0.95, while the $OR_{\text{stem nodes-outer medium}}$ rose from 0.99 to 2.4. It therefore appears possible that the range in the observed value for the $OR_{\text{total shoot-outer medium}}$ may largely reflect contrasting experimental conditions and, furthermore, that when plants differ in their growth habits, no consistent relationship can be expected between their OR values. Reports of varying ratios of native calcium to strontium in miscellaneous fragments of wild plants (*13*) at different stages of their development therefore provide no basis for interspecific comparisons. The available evidence thus points to the conclusion that little discrimination between the dietary calcium and strontium of man or animals occurs in its passage through plants. Fuller information with regard to storage organs is, however, desirable.

Plant/Soil Relationships

The similarity of the behavior of strontium and calcium in plants has, not surprisingly, encouraged the hope that the absorption of strontium-90 from soil can be reduced by addition of lime. Unfortunately this optimistic generalization is not supported by experimental evidence. The majority of the data now available have been derived from small-scale experiments, but a sufficiently wide range of soils has been used for a broad pattern to be apparent for a reasonable range of agricultural soils in temperate climates. Fuller and Flocker (*14*) found that lime equivalent to 2 tons per acre reduced the strontium content of plants grown in an acid forest soil by nearly one-fifth, and the strontium-89-to-calcium ratio was lowered by more than 45 percent. However, much smaller and highly variable

Table 1. Effect of lime applied at a rate equivalent to 2 tons per acre on the strontium*-to-calcium ratio in cereals (after Fuller and Flocker, *14*).

Soil	Exchangeable Ca (milliequivalents/100 g)	Lime	Sr (%)	Ca/Sr ratio
Pima clay loam	30.0	−	0.00408	48
Pima clay loam	30.0	+	0.00353	59
Chino clay	20.4	−	0.00350	64
Chino clay	20.4	+	0.00364	69
Sandy loam from Flagstaff	17.9	−	0.00656	32
Sandy loam from Flagstaff	17.9	+	0.00600	39
Gila sandy clay loam	17.7	−	0.00713	35
Gila sandy clay loam	17.7	+	0.00684	39
Mohave sandy clay loam	15.4	−	0.00931	26
Mohave sandy clay loam	15.4	+	0.00902	26
Laveen sandy loam	8.6	−	0.00942	19
Laveen sandy loam	8.6	+	0.00919	21
Tucson sandy loam	8.4	−	0.01224	19
Tucson sandy loam	8.4	+	0.01094	20
Tubac sandy loam	8.0	−	0.01001	16
Tubac sandy loam	8.0	+	0.00953	17
Tucson sandy loam	7.5	−	0.01304	17
Tucson sandy loam	7.5	+	0.01299	19
Pima sand loam	5.0	−	0.01704	14
Pima sand loam	5.0	+	0.01953	13
Least significant difference 0.05 for $CaCO_3$ treatment only			0.00031	4

effects occurred in a wide range of agricultural soils (Table 1). Fuller and Flocker concluded that "little practical significance attaches to the effect of lime."

Romney *et al.* (*10*) found that calcium carbonate at a rate equivalent to 2 to 5 tons per acre reduced the absorption of strontium-90 from a soil very poor in calcium by approximately 60 percent. Higher dressing caused no further reduction, and the dressing that reduced the absorption of strontium-90 was similar to that necessary to insure good crop production. Calcium sulfate caused a greater reduction in the absorption of strontium-90. Neither treatment, however, caused a significant effect when the soils contained calcium in the range optimal for growth of crops. Reitemeier (*15*) has reported a significant reduction of the strontium-89-to-calcium ratio in soybeans, but not in bluegrass, when 4 tons of lime per acre was rotary-tilled into the upper 6 inches of a contaminated silt loam having an initial *p*H of 5.2. Surface applications of lime at the same rate had no significant effect on the ratio in either crop. In a field-scale experiment on a calcareous soil in the United Kingdom, lime at the rate of 2 tons per acre has been without effect on the absorption of strontium-89 or on the strontium*-to-calcium ratio (*16*). It appears in general that, when soils contain sufficient lime to promote good growth of crops, further additions will provide little protection against strontium-90. Fuller investigations of acid soil types are, however, desirable; no data for tropical and subtropical conditions are yet available.

Despite the lack of any great effect of liming on the strontium-90 content of plants grown in many soils, a close negative correlation exists between the quantity of strontium absorbed by plants and the quantity of calcium that can be displaced from soils by the ammonium ion (*14*). A comparable relationship holds between the absorption of strontium by the plant and the quantity of isotopically exchangeable calcium in soils (*17*). The explanation of this seemingly paradoxical situation must be sought in the physicochemical reactions by which calcium and strontium can be retained in the soil or in the rate of reaction of liming materials with soils. Although these mechanisms are as yet very incompletely understood, there is abundant evidence of their complexity. For example, when soils are suspended in solutions of labeled calcium, a rapid isotopic exchange of calcium occurs in 1 day or less, but thereafter a slow exchange reaction may continue so that isotopic equilibrium is not reached in some soils even after 2 weeks or more.

Interesting information has also been obtained from experiments in which carrier-free strontium-89 or strontium-90 was added to soils from which labile cations were subsequently extracted. When the time between contamination with strontium-89 and extraction was increased from 2 to 71 days, the ratio of strontium-89 to calcium decreased from 9.5 to 6.9 and from 3.6 to 2.6 for a light acid soil and a heavy clay, respectively (*17*). It has also been observed, especially in calcareous soils, that the ratio decreases if the extraction procedure is made more rigorous so that larger quantities of calcium are removed. For example, in a highly calcareous soil derived from coral contaminated with radioactive fallout, the strontium-90-to-calcium ratio fell by a factor of 4 when the period of extraction with normal ammonium acetate was extended from 1 to 14 days (*18*). The extent of this effect may vary greatly among soils.

Before the advent of tracer methods, it was impossible to observe relationships of the types discussed in the foregoing paragraphs, and much work must be carried out before the situation is clear. Nonetheless, present information justifies some conclusions.

1) Although the widely varying reaction of soils makes generalization difficult, present findings suggest that the addition of lime is unlikely to reduce the absorption of fallout strontium-90 to an extent which is of practical importance except in soils for which this treatment is desirable to obtain good crops.

2) The complexity of the equilibria in which calcium and strontium take part in soil is such that no simple relationship can be expected between the total calcium in the soil and that which "dilutes" fallout strontium-90 on its entry into plants. For this reason, the effective ratio of strontium-90 to calcium in the soil cannot readily be determined. The comparison of strontium-to-calcium ratios in plants with those in soil is therefore not necessarily a valid measure of the manner in which plants discriminate between the two ions. This may explain why some experiments on plants grown in soil have suggested a marked discrimination against strontium as compared with calcium (*19*).

3) The decrease in the ratios of strontium-90 to calcium observed when soils are extracted at intervals after the addition of strontium-90 suggests that the accessibility of strontium to plants may progressively decrease. Conclusive evidence on this important question can, however, be obtained only in prolonged experiments.

Movement of Strontium-90 in Soils

Both laboratory experiments and surveys of current fallout indicate that strontium-90 penetrates to only a small depth below the soil surface. The greater part of the deposition remains in the upper 2 inches of soil for considerable periods (*12, 20*). This immobility precludes the possibility that deposits of mineral calcium that may be used for dietary purposes will become contaminated. Many factors, however, will affect the depth of penetration of strontium-90 in the upper soil layers; for example, the nature of the soil, the extent of leaching

by rain, the action of worms, and the cracking of the soil in dry weather.

The results of different soil-leaching treatments (*21*) suggest that the movement of strontium-90 in the soil could be greatly accelerated only by drastic treatments, which could be highly expensive and often very injurious to soil structure and fertility.

Fraction of Total Strontium-90 Absorbed by Plants

Part of the fallout descending from the stratosphere will lodge in plants, and part will enter the soil whence it may enter plants through their roots. If the long-term effects of fallout are to be adequately assessed, it is of fundamental importance to estimate the relative extent to which these two sources are responsible for the observed contamination of herbage. If aerial deposition is the major source, the level of contamination would depend on current fallout. If, however, absorption from the soil is the major source, the quantity of strontium-90 in herbage will be related to the total fallout which has reached the soil. An accurate estimate of the fraction of strontium-90 in soil that will be absorbed by crops each year is, however, necessary for an adequate assessment of the long-term situation. This cannot readily be achieved by surveys of current contamination, and the possibility of obtaining this information by tracer experiments has therefore been considered.

Strontium-89 or strontium-90 in carrier-free form can be applied as a fine spray to the soil surface, and the subsequent entry of either into crops can be measured with precision. This approach assumes that the tracer applied as a fine spray will behave similarly to strontium-90 in fallout. This appears to be a reasonable assumption, provided that the strontium-90 in fallout is relatively soluble or will be liberated in an ionic form subsequent to its incorporation in the soil. There is evidence that world-wide fallout possesses these characteristics (*22*). Thus the behavior of strontium-90, whether applied as a tracer or in fallout, can be expected to be similar; it will enter the cation exchange complex of the soil whence it may slowly enter plants. The absorption of plants may initially be overestimated by the tracer method if a significant period elapses before a fraction of the fallout strontium-90 passes into a free ionic form from the particles in which it is deposited, but the slow rate at which strontium-90 is withdrawn from the soil by plants should make such effects small.

Table 2. Strontium-89 content of crops expressed as a percentage of the quantity of carrier-free strontium-89 applied as spray to the soil surface (*16*).

	Yield per acre (tons)	Sr-89 content as percentage of dose applied
	Ryegrass	
First cut	0.95	0.39 ± 0.03
Second cut	0.35	0.072 ± 0.005
Total		0.46
	Barley	
Grain	1.3	0.016 ± 0.0018
Straw		0.106 ± 0.0073
Total		0.122
	Sugar beet	
Roots	8.2	0.17 ± 0.01
Tops		0.61 ± 0.2
Total		0.78

Table 3. Summary of comparative strontium-to-calcium ratios in bodies and diets of various species. The OR values were determined from bone or blood values or by calculation of amounts retained from excreta values; range or mean ± standard error of mean are given where available.

Species	Diet	Method	Remarks	$OR_{body-diet}$	Reference
Man	Milk	Double tracer with each meal	4 patients, 9 to 73 years old	0.54 (0.50–0.62)	(*32*)
Man	Normal mixed	Stable Sr/Ca ratios	1 normal	0.24	(*40*)
Man	Nonmilk	Double tracer with each meal	4 patients	0.44 (0.37–0.51)	(*32*)
Man	Nonmilk	Double tracer, single dose	2 patients	0.35 (0.25, 0.45)	(*41*)
Rat	Milk	Double tracer in dietary		0.57 ± 0.02	(*5*)
Rat	Nonmilk	Double tracer in dietary		0.27 ± 0.01	(*5*)
Rat	Nonmilk	Lifetime feeding of Sr*/Ca		0.28	(*7*)
Rat	Nonmilk	Stable Sr/Ca ratios		0.27	(*6*)
Goat	Nonmilk	Double tracer, daily dose	2 animals	0.23	(*42*)
Mouse	Nonmilk	Stable Sr/Ca ratios		0.35	(*6*)
Guinea pig	Nonmilk	Stable Sr/Ca ratios		0.22	(*6*)
Jack rabbit	Natural (on desert)	Stable Sr/Ca ratios		0.20	(*6*)
Cottontail rabbit	Natural (on desert)	Stable Sr/Ca ratios		0.22	(*6*)
Kangaroo rat	Natural (on desert)	Stable Sr/Ca ratios		0.16	(*6*)

It is important that experiments of this type should be carried out under field conditions. Few results are yet available, but the first of a series of experiments of this type may, however, be considered (*16*). The purpose of the experiment was to determine the extent to which contamination was absorbed in one season by three crops—rye grass, sugar beet, and barley. A calcareous downland soil at Compton, Berkshire, England, was employed. Strontium-89 was applied as a fine spray, and, after contamination of the land, three types of cultivation were employed to prepare the seed bed. Land carrying stubble at the time of contamination was compared with fallow. The mean percentage of the applied strontium-89 recovered from the three crops in all treatments is shown in Table 2. The highest values were, as was expected, in leaf tissue. The totals for the three species varied from 0.12 to 0.78 percent. Reitemeier (15) has reported values ranging from 0.5 to 1.5 percent. The cultivation treatments and the condition of the land at the time of cultivation influenced absorption, but only to a relatively small extent. Since these effects differed between crops and, furthermore, are expected to change with soil type, a detailed discussion is inappropriate. The present inference, however, is that the method of cultivation appears unlikely to alter the absorption of fission products by a factor exceeding 2. The extension of this type of investigation to long-term studies with strontium-90 on permanent pastures is highly desirable.

On theoretical grounds it had been considered that 1 percent might be a medium value for the fraction of the fission-product strontium-90 (in soil) that plants absorb in a single season. The present results suggest that, in some instances, this speculation is of the correct order of magnitude. Wide variations must, however, be expected. When soils are very shallow, as they are in some hill pastures, and the soil surface is virtually a root mat, conditions are clearly in sharp contrast to those in normal agricultural land. The rate of absorption of

recently added strontium-90 under such circumstances may well be much enhanced; whether, however, the total absorption over a prolonged period will be greater is a different question. No precise data for such situations are available, but it seems possible that this may in part explain sporadic exceptionally high values for the strontium-90 to calcium ratio (*23*). The detailed study of plant-to-soil relationships under such conditions is clearly desirable.

Discrimination in Man and Animals

Experimental evidence on the discrimination that occurs against strontium in favor of calcium between the diet and body is summarized in Table 3. Several conclusions may be drawn from these data. (i) From the rat experiments, which were probably the best controlled, it is clear that identical results were obtained either by short-term double-tracer techniques, lifetime feeding of a "strontium*-spiked" diet, or the analyses of stable strontium-to-calcium ratios in diet and bone. (ii) In all species on the nonmilk diet, the ratio of strontium to calcium of the body ranged from 0.16 to 0.51 of that of the diet; the average values for man were in the range from 0.24 to 0.44. The value of 0.23 for the goat may be used as representative of muscle tissue in domestic animals for calculation of the contribution of meat to the strontium-90-to-calcium ratio in the population. (iii) In man and rats having milk in the diet, the OR values were 0.54 and 0.57, respectively.

It is recognized that relatively few studies have been done on man, and these often on chronically ill patients having malignant neoplasms. Nevertheless, examination of the individual results indicates that the OR values were remarkably the same in patients having different diseases (for example, leukemia versus ovarian tumor). This, plus the general agreement with the values from other animals, permits some degree of credence in the results. Kulp *et al.* (*24*) have reported an over-all discrimination factor of 8 (0.13 in our terminology) against strontium in going from food to bones in man, based on interpretations from single intravenous dosages; this appears to be a greater discrimination than that expected from the direct observations reported in Table 3.

Minor Discrimination

To gain understanding of how the discrimination is caused, it is necessary to consider the individual processes that are operative. From a practical standpoint, this information is essential to permit a logical approach toward modification of these processes to cause decreased strontium accumulation. It is convenient to treat first the less important physiological processes, since this permits quantitative discussion of the more important ones later on.

The movements of alkaline earths between circulating fluids and bone result from ion exchange, accretion, resorption and deposition in growth, and remodeling of Haversian systems. Three types of experiments have given data on the comparative movement between circulating fluids and bone. In the double-tracer studies at steady state, described in Table 3, it was noted for one patient, for rats, and for goats that the $OR_{bone\text{-}diet}$ values were about the same as for $OR_{blood\text{-}diet}$. If anything, there was a tendency in the rat for the $OR_{bone\text{-}diet}$ to be slightly higher, indicating an over-all preferential movement of strontium from blood to bone. Further details are available from tissue-culture studies in which chick embryo bone was grown in substrate containing constant levels of strontium-89 and calcium-45 (*25*). For short experimental periods, the $OR_{bone\text{-}substrate}$ was 1.08, suggesting a slight preferential movement of strontium into the bone. When labeled bone was placed in unlabeled substrate, it was calculated that the strontium-89 was released from the bone at a ratio of 1.2 times that of calcium-45. This finding was confirmed in studies with rats in which previously deposited strontium-85 and calcium-45 were removed from nephrectomized rats by peritoneal lavage; the $OR_{lavage\ solution\text{-}bone}$ was 1.3 (*26*). It was necessary to use nephrectomized animals to avoid the discriminatory effects of the kidney, which masked the bone-circulating fluid effects. From kinetic studies of radioisotopes of strontium and calcium, Bauer *et al.* (*27*) also concluded that there was no marked difference between the two elements with regard to skeletal accretion and exchange, as did MacDonald *et al.* (*28*) from studies with nephrectomized rats. It appears, then, that strontium tends to be preferentially deposited and removed from bone, but these processes make little contribution to the over-all discrimination.

The excretion of circulating strontium and calcium into the lumen of the gastrointestinal tract could be a cause of discrimination. Greenberg and Troescher (*29*) reported essentially the same excretion rate for the two isotopes in the bile of rats. Singer *et al.* (*30*), however, showed that in the dog the biliary excretion of strontium* was about twice that of calcium.* In the same experiments it was also shown that, in the total endogenous excretion, only about 20 percent more strontium* than calcium* appeared in the gastrointestinal tract; the biliary strontium* and calcium* comprised only 6 to 9 percent of the total endogenous excretion. It is thus considered that this process does not contribute significantly to over-all discrimination.

Major Discrimination

It appears that only absorptive and urinary discrimination are of importance in the nonpregnant, nonlactating animal. The following equations have been used to calculate the relative contribution of each process; they are based on the assumption that urinary excretions are proportional to the amounts absorbed (*5*).

$$DF_{absorptive} = \frac{100 - \%\ \text{ingested Sr in feces}}{100 - \%\ \text{ingested Ca in feces}} \qquad (3)$$

$$DF_{urinary} = \frac{OR_{body\text{-}diet}}{DF_{absorptive}} \qquad (4)$$

Table 4 presents a summary of the relative contributions of absorption and urinary excretion to the discrimination in man and rat. Again, there seems to be general agreement between these two species. It is noted that milk apparently reduced the absorptive discrimination but had little effect on urinary discrimination. On a milk diet, the contributions of both processes were about equal; on a nonmilk diet, the absorptive process was more important.

Of greatest practical importance is the reduction of strontium-to-calcium ratio that occurs in passage of these elements from the fodder of the cow to the milk. Table 5 summarizes values obtained experimentally by double-tracer feeding, by surveys of fallout strontium-90, and by analyses of stable strontium-to-calcium ratios in feed and milk. Again, there is good agreement among all observations, and there is little question that, under conditions of daily intake, the strontium*-to-calcium ratio of the milk will be about 0.1 to 0.14 that of the ra-

Table 4. Relative contributions of absorption and urinary excretion to strontium-calcium discrimination in man and rat.

Item	One patient on milk (*32*)	Rats on milk (*5*)	Two patients on nonmilk (*41*)	Rats on nonmilk (*5*)
$OR_{bone\text{-}diet}$		0.57		0.27
$OR_{retained\text{-}diet}$			0.35	
$OR_{blood\text{-}diet}$	0.62			
$DF_{absorptive}$	0.78	0.68	0.46	0.34
$DF_{urinary}$	0.87	0.84	0.75	0.88

Table 5. Comparative strontium-to-calcium ratios in the milk and feed of the cow and goat.

Species	Method	$OR_{milk-diet}$	Reference
Goat	Two animals on double-tracer daily feeding for 13 days	0.08, 0.10	(*42*)
Cow	Daily and single feeding of Sr* and Ca* at different times	0.14	(*39*)
Cow	Sr^{90} assays of Wisconsin milkshed, 1953	0.16	(*3*)
Cow	Sr^{90} assays of Wisconsin milkshed, 1955	0.15	(*22*)
Cow	Sr^{90} assays in United Kingdom, 1955	0.09	(*23*)
Cow	Stable Sr and Ca ratios in feed and milk from New York area	0.12	(*20*)

tion being consumed by the animal. The studies on goats give further details—for example, $OR_{plasma-diet} = 0.24$; $OR_{milk-diet} = 0.09$. It is noted that, in going from the blood of the goat to the milk, there was a reduction in the strontium-to-calcium ratio by a factor of 0.38. Another important point, which has been anticipated on theoretical grounds, has been strongly supported by the survey results; this is the fact that the level of strontium-90 in the milk is mainly a reflection of current strontium-90 intake and is not greatly influenced by the strontium-90 level in the cow's skeleton as a whole.

The comparative passage of strontium and calcium from dam to fetus has been studied in rats and rabbits (*7, 31*). In general, the placental transfer of strontium was about one-half of that of calcium; the major site of discrimination was the placental barrier, with differential movement occurring in passage from dam to fetus but with no differential movement from fetus to dam. Under steady-state conditions in the rat, $OR_{dam-diet}$ was 0.28, and the $OR_{fetus-diet}$ was 0.17. The over-all discrimination of 0.17 between fetus and diet resulted from absorption ($DF_{absorptive} = 0.42$), urinary excretion ($DF_{urinary} = 0.63$), and placental transfer ($DF_{placental-fetus} = 0.65$). In the rat it was estimated that 92 percent of the fetal calcium had originated from the maternal diet. Of practical importance, this means that strontium content of the fetal calcium will be governed mainly by the strontium content of the calcium ingested by the mother shortly before or during gestation.

Factors That Affect Discrimination

It is important to know whether or how the strontium-calcium discrimination is affected by age. Comar *et al.* (7) showed that there was no difference in discrimination in rats between 70- and 400-gram body weight. The data from steady-state double-tracer studies on human subjects (*32*) indicated no large differences between persons ranging from 9 to 73 years; it must be noted that there were only a few persons in these experiments. Sowden and Stitch (*33*) reported as follows from analyses of stable strontium: bone strontium values in the newborn were low (as would be expected from fetal discrimination); between 6 and 74 years of age there was a tendency for the strontium values to increase. Unfortunately there are no data for very young children. Theoretically one might expect the discrimination in the very young to be decreased because of increased absorption and retention of both alkaline earths. This has been recently confirmed in studies with rats on a milk diet in which the $OR_{bone-diet}$ was 0.78, 0.62, and 0.45 at 15, 48, and 194 days of age, respectively.

Of the dietary factors that might affect discrimination, milk appears to be important. As has already been mentioned, milk tends to reduce discrimination primarily by its effect on the absorptive process. In the work that pointed the way to the milk effects, Wasserman *et al.* (*34*) showed that substances, such as lactose, lysine, and arginine, that tended to increase calcium absorption were even more effective in increasing strontium absorption. Eighteen other amino acids, including those essential for the rat, were shown to have little or no effect. Other substances such as sodium gluconate, sodium lactate, and B vitamins were shown to be without effect. Further work, as yet unpublished, indicated that ingestion of complexing agents such as phytate and citrate, when incorporated in fluid milk, had no effect; however, the sodium salt of ethylenediaminetetraacetic acid markedly decreased the discrimination by raising the strontium retention and at the same time slightly lowering the calcium retention.

The effect of dietary calcium level on discrimination is now considered. Short-term or single-dose studies usually indicate that raising the calcium level does not proportionally decrease the strontium burden. For example, in rats it was found necessary to raise the calcium content 2000-fold to reduce the strontium-90 retention by half (*35*). This probably happens, however, because the animal tends to absorb more calcium when the calcium level is raised on a short-term basis. Preliminary results of longer-term feeding studies with rats receiving diets supplemented with calcium carbonate in the normal range indicated that the retention of ingested radiostrontium was inversely proportional to the calcium level of the diet (*36*). When these calcium levels (0.5 to 2.0 percent calcium in diet) were fed for 15 days, the fourfold increase in dietary calcium decreased radiostrontium retention in the rat by a factor of 3; at 45 days, a true stoichiometric relationship was observed. Thus it appears that the usual laws of isotope dilution were operative. It was also shown that the $OR_{bone-diet}$ value was the same in rats on a normal milk diet and those on milk supplemented with calcium gluconate to contain 3 times the normal calcium content.

Discrimination between Vegetation and the Human Skeleton

It is possible to make some estimates, based on the experimental evidence already presented, about the relationships that will exist between the strontium*-to-calcium ratio of the vegetation and that in the human population when steady-state conditions have been attained. Account must be taken of the sources of dietary calcium, which will depend to a certain extent on the food technology and food habits of the region. Infants receive their calcium predominantly from cow's milk or mother's milk. In the United Kingdom, it has been estimated that the sources of calcium in the average diets of the whole population are as follows: 56 percent from dairy products; 16 percent from vegetable produce; 4 percent from meat and eggs; and 21 percent from mineral sources, primarily in fortified bread. In the United States, bread is fortified with milk solids, and it is estimated that 70 to 80 percent of the dietary calcium comes from dairy products, 14 to 20 percent from vegetable produce, and about 5 percent from meat and eggs (*37*).

When it is remembered that the strontium*-to-calcium ratio in milk is 0.1 to 0.14 of that in vegetation, it appears that plant strontium-90 should not be overlooked as an important source in the average diet. The contribution from vegetable foods, however, may be somewhat reduced because washing and removal of outer leaves causes the strontium-90-to-calcium ratio in vegetable produce consumed by man to be less than that in herbage consumed by animals; furthermore, seeds and tubers, which are not exposed to aerial contamination, may

contribute some calcium to the human diet. There are insufficieint data to permit such considerations to be taken into account. Water supplies are not considered an important source of strontium-90 because of the great dilution that takes place, the fixation of the radioisotope upon soil or rock particles, and the soil filtration of water that comes from wells or springs.

In Table 6, some estimates (based on rounded-off values) are presented of the relationship between the strontium-90-to-calcium ratio in vegetation and the strontium-90-to-calcium ratio in the skeletons for populations in the United States deriving their dietary calcium from the sources stated. The contribution of strontium-90 from fish sources appears to be small and is neglected; the effect of mineral sources of calcium is also neglected, except for the known levels used in the United Kingdom. Because of the complexity of the factors that influence the $OR_{vegetation\text{-}soil}$, no assessment of the relationships between the ratio of strontium-90 to calcium in soil and that in man has been attempted.

Estimates were made for the newborn and 6-month-old child because of the additional discrimination that occurs in fetal development and that might be caused by feeding on mother's milk. It seems, therefore, that the newborn and very young children should develop a strontium*-to-calcium ratio of 0.04 to 0.12 of that existing in the vegetation; these values range from 0.08 to 0.16 for older persons. Similar calculations based on the dietary sources in the United Kingdom give values of 0.035 to 0.11 for the newborn and young children, and 0.07 to 0.12 for older persons. The survey data on strontium-90-to-calcium ratios in children as related to that in vegetation, so far, appear to show greater discrimination against strontium than expected from the foregoing. It is impossible on the basis of present data to determine whether this is the result of underestimation of the discrimination factors, of differences in dietary habits, or of equilibrium not yet having been attained. Another point of uncertainty is that calcium and strontium from different sources may not be utilized to the same extent. The relationship between stable strontium-to-calcium ratios in human bone and in sedimentary rocks (*38*) is, however, in reasonable agreement with the values presented for adults. As more precise information becomes available on food habits and dietary calcium sources, these data can be treated according to the principles developed in Table 6. The values can also be adjusted if future work demonstrates that fallout strontium-90 becomes significantly less available with time or if procedures such as plowing produce significant dilution as related to the feeding zone of certain crops.

Reducing the Extent to Which Fallout Enters Food Chains

The failure of lime to provide protection universally against the absorption of strontium-90 by crops encourages the search for other remedies. No satisfactory procedure has yet been demonstrated. It is impracticable to remove the contamination by leaching, and the modification of cultivation procedures in arable land seems likely to have only a small effect; however, these are matters that require further study.

The quantity of strontium-90 absorbed could be reduced, however, by cultivating crops that possess one or both of the following characteristics: a low concentration of strontium and calcium in their edible tissues, or a deep-rooting habit that causes them to absorb the greater part of their nutrients from below the level to which contamination has penetrated. The cultivation of crops containing a low concentration of strontium could reduce the strontium-90 intake of the population. However, since plants differ little in their OR values, the calcium content of diets would be reduced. This procedure would therefore have obvious limitations unless alternative sources of dietary calcium were provided. However, in wartime emergency, survival might be aided by the cultivation of crops low in calcium relative to their calorific value. On this basis, the potato, which contains in the order of 10 milligrams of calcium per 100 calories, is a particularly suitable crop; leafy vegetables may contain 10 to 100 times as much calcium per 100 calories.

Information is, unfortunately, lacking on the extent to which different species absorb calcium from more than 6 inches below the soil surface. The very great differences existing in root structures between different grass and legume constituents of pasture suggest, however, that plants may contrast markedly in this respect. The cultivation of species that absorb relatively little from the upper 4 to 6 inches of soil would appear to be the most practicable method for reducing the strontium-90-to-calcium ratio in herbage. Thus the investigation of the pattern of absorption by agriculturally important species is a subject of particular interest.

Table 6. Assumptions and estimated relationships between strontium*-to-calcium ratios in vegetation and the human population in the United States.

Age	$\frac{\text{Sr*/Ca of human bone}}{\text{Sr*/Ca of vegetation}}$	Assumptions
Newborn	0.04 to 0.08	70 to 80 percent of mother's calcium derived from milk; discrimination from feed to cow's milk = 0.1 to 0.14; discrimination from milk to mother's body = 0.5; 14 to 20 percent of mother's calcium of vegetable origin; discrimination from plant food to mother's body = 0.25 to 0.5; 5 percent of mother's calcium derived from meat and eggs; discrimination from vegetation to meat and eggs = 0.25; discrimination from meat and eggs to mother's body = 0.25 to 0.5; discrimination across placenta = 0.5.
Six months	0.037 to 0.12	67 percent of calcium had been laid down *in utero* with maximum discrimination, and child was nursed on mother's milk with maximum discrimination of 0.03; or, 33 percent of calcium had been laid down *in utero* with minimum discrimination, and child was fed on cow's milk with minimum discrimination of 0.14.
Over 6 months	0.08 to 0.16	Same as for newborn except that there is no placental discrimination.

Sample calculation for maximum in utero discrimination

% of mother's Ca from milk		discr. from feed to cow's milk		discr. from milk to mother's body		% of mother's Ca from plants		discr. from plant food to mother's body		% of mother's Ca from meat and eggs		discr. from feed to meat and eggs		discr. from meat and eggs to mother's body		discr. across placenta		
[(0.8	×	0.10	×	0.5)	+	(0.14	×	0.25)	+	(0.05	×	0.25	×	0.25)]	×	0.5	=	0.04

Steps to reduce the strontium-90 burden in the population by procedures with man and animals would first be concerned with assuring that an uncontaminated source of calcium contributed a maximum proportion of the dietary calcium. As has already been noted, the immobility of strontium-90 in soil would protect deposits of mineral calcium from contamination. Thus one might use mineral sources of calcium as much as possible and plant sources at a minimum. The evidence that discrimination between the two elements can be changed by dietary alterations (milk, lactose, lysine) gives some reason to believe that further research could provide an effective modification in either direction.

The possibility of using increased dietary calcium to reduce the amount of radioactive strontium entering milk has been previously reported (*39*). Short-term studies with dairy cows indicated that a fourfold elevation of dietary calcium caused only a 35-percent reduction in the strontium-90 content of the milk. Judging from the longer term rat studies previously mentioned (*36*), one might expect that stoichiometric reduction of strontium-90-to-calcium ratios should occur from supplementation of rations with uncontaminated calcium. It is emphasized, however, that further work is needed to determine whether such supplementation of dairy rations would indeed be effective and feasible. Again, judging from the longer term rat studies, it might be possible to decrease stoichiometrically the strontium-90-to-calcium ratio in man by supplementation of his diet over the years with uncontaminated calcium; but, as always, definite proof of this point must await direct observations on man. At present, mineral calcium is used to fortify flour in some countries, for example, the United Kingdom; but it would be much more difficult to justify large increases in dietary calcium for the human population than it would be to justify similar modifications of animal rations. There is, of course, the possibility of supplementation with stable strontium. Since it would most likely be necessary to use the same levels of strontium as of calcium, it is perhaps more useful to focus attention on the more physiological element, calcium.

The discussion of methods for reducing the extent to which fallout enters food chains is not meant to imply that remedial measures are now necessary. Such considerations, and in addition the matter of how much reduction would be of practical significance, are beyond the scope of this paper.

Summary

The calcium reservoirs of the biosphere are becoming labeled to varying degrees with strontium-90 from nuclear weapons. These reservoirs include the human and animal skeleton, the milk, the vegetation, the upper layers of soil, and the waters. The degree of labeling is governed by the dilution that occurs, or the differential behavior of calcium and strontium in various steps of the food chain. This differential behavior normally provides a factor of protection against strontium-90 in the soil and vegetation that may be as high as 25 for the newborn and is most likely not less than 6 for adults, depending on food habits.

The physiological steps that are important in the movement of the two elements in the biosphere are described to provide a basis for an approach toward increase of the discrimination against strontium in favor of calcium. Some aspects of agricultural practices are discussed from this standpoint. The matter of hazard from levels now existing and the present need to undertake remedial measures are not discussed, in major part because of lack of experimental data on which to base such considerations.

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Stockholm Natural Radiocarbon Measurements I

H. G. Ostlund

After almost a year of construction and trouble, radiocarbon dating work in Stockholm began early in 1955 with the black-carbon method, using the double screen-wall counter of the type developed in Copenhagen (*1*). However, after only a few months, it was evident that the measuring techniques had to be changed because of several disturbances from airborne radioactive contamination. In the autumn of 1955, construction was started of the present carbon dioxide proportional-counting apparatus. This apparatus came into routine operation early in 1956. Tables 1 and 2 give the results obtained using the black-carbon method (indicated by an asterisk) and the new method up to 12 May 1957 (*2*), when the apparatus was demounted for transportation from the temporary localities in the Royal Institute of Technology to the Swedish Geological Survey.

Techniques

The preparation and measuring methods now used are similar to those used by the Groningen (*3*), New Zealand (*4*), and Lamont (*5*) laboratories. A few facts only are given here (*6*).

The sample is converted to extremely pure carbon dioxide, taking care to exclude the carbon dioxide of the air. The proportional-counting tube has a net volume of 1.00 liter and a working pressure of 3 bar. Each sample is counted at least two times, for 20 hours each time, and with 14 days between the two periods. Before every counting period, the purity of the gas is carefully controlled by checking the gas amplification by means of an external source of radioactivity.

Oak tree rings grown about A.D. 1850 are used as a standard. Thereby we avoid the isotopic dilution effect on modern plant carbon caused by the industrial burning of coal and oil. This effect has been observed by Suess (*7*). The variation of the isotopic composition of the carbon of living plants and animals (*8*), together with possible isotopic fractionation in the preparation of the sample, has an influence on the activity of the sample. Therefore, all purified carbon dioxide samples for gas counting, except those with zero activity, have been mass-spectrometrically analyzed for their C^{13}/C^{12} ratio (*6, 9*).

Our counter characteristics follow: modern carbon, 18.5 C^{14} counts per minute over the background of 3.78 counts per minute, the former figure having been calculated from measurements of our standard wood. The background figure has a distinct dependence on atmospheric pressure, as is shown in Fig. 1. The solar flare on 23 February 1956 caused a small effect on the counting rate; the result obtained that day was rejected. With the exception of the effect mentioned, no sample has ever shown other uncontrolled fluctuations than those expected from purely statistical reasons.

Calculations

The ages given in Tables 1 and 2 were calculated by using the adopted value of a half-life of 5568 ± 30 years for C^{14}, assuming sufficient long-time constancy of the natural radiocarbon production, and trusting the physical correctness and freedom from organic materials of wrong age of the samples when submitted to the laboratory.

For calculation of the age, the net count rate of the sample, as obtained from the actual measurings of the sample itself, and the background figure taken from a curve consistent with Fig. 1, and corrected according to the C^{13} analysis are used. The net count for modern carbon is obtained as the average calculated from several measurements in the same manner.

The errors σ_A in the ages are obtained from the equation

$$\sigma_A = \frac{t_{\frac{1}{2}}}{\ln 2}[E_R^2 + (E_{\frac{1}{2}} \cdot \ln R)_2 + (2E_{13})^2]^{\frac{1}{2}}$$

where E_R is the relative error in the ratio R between numbers of C^{14} counts per minute in the standard and in the sample; $E_{\frac{1}{2}}$ is the relative error in the half-life, and E_{13} the relative error in the measurement of the C^{13}/C^{12} ratio (± 0.1 percent). Of these three parts, E_R gives by far the greatest contribution. E_R is calculated from the relative errors of the sample and modern carbon net count

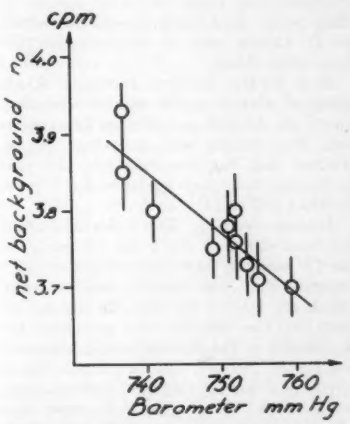

Fig. 1. Influence of the atmospheric pressure on the net background counting rate during September, October, and November 1956.

Table 1. Radiocarbon measurements of industrial samples.

Description	Sample No.	Isotopic composition correspondence
Korsnäs Ltd., Gävle, Sweden. Organic incrust inside a boiler tube in the Korsnäs cellulose works. The object was to determine the origin of the incrust, whether from petroleum or cellulose. Submitted by W. Rosén.	St-16*	47.5 ± 1.6% recent carbon
Ostrand Manufacturing Co., Timrå, Sweden. Barium carbonate made from highly chlorinated organic compounds in the chlorine plant. The purpose was to determine whether the compounds were formed from the action of chlorine on ebonite or on graphite. Submitted and described by G. Wranglén (*10*, p. 401).	St-141	30 ± 1% recent carbon

* Measurement made by the black-carbon method.

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rates, the errors in these rates being calculated according to the afore-mentioned method. Lower values of σ than ± 0.03 count per minute for background and ± 0.06 count per minute for modern carbon rates have not been used, even when lower figures were formally defensible, owing to the great number of measurements.

When a minimum age is given, it corresponds to 3σ in the net count of the very old sample, added to the actual net count rate, negative rate taken as zero. This calculation thus gives 99.86 percent or better certainty in the statement (*3*).

Table 2. Radiocarbon datings. All ages are given in years before the present. All samples, except when it is otherwise stated, were collected in Sweden. Determinations made by the black-carbon method are marked by an asterisk (*) after the sample number.

Description	Sample No.	Age
I. *Cross-check samples and samples of known age*		
Angelsta, Småland. Hewed stub of fir, found at a depth of 3.5 m in Rya Moor, Angelsta, together with a fragment of diorite, possibly a part of a stone axe. Several kilograms of the wood are at our disposal, and the material is in an excellent state of preservation. Submitted by the Museum of National Antiquities, Stockholm.		
Tree rings No. 1 to 50 from the core, dated by the black-carbon method.	St-13*	2560 ± 190
Tree rings No. 101 to 150 from the core, dated by the carbon dioxide method. The same rings were dated at the Lamont laboratory (sample L-296), and an age of 2600 ± 80 yr was obtained (*11*).	St-156	2470 ± 65
Lake Nemi, Italy. Wood from one of Caligula's ships. Historically dated to about A.D. 50. The sample was taken from the innermost tree rings. The total number of rings to the bark is not known. Submitted by C. Cortesi and M. Beneventano, C^{14} laboratory, Rome.	St-103A St-103B	1940 ± 70 2090 ± 75 Average 2010 ± 65
Ruds Vedby, Zealand, Denmark. Small pieces of wood from the zone boundary between the Alleröd and younger Dryas periods. The sample was submitted by H. Tauber, and has been dated by the Copenhagen laboratory (sample K-101) to 10,890 ± 240 yr (*1*).	St-18*	10,200 ± 370
Sequoia tree rings. This series of samples has been dated to check the reliability of the C^{14} method, since a recent paper (*12*) suggests that one would obtain results which are 200 yr too high for an age of 2000 yr. The samples were submitted by R. Sievert at the Radiophysical Institute, Stockholm. No one but he himself knew anything about the ring age of the samples we received. We were told the exact age when a signed certificate with our values was given to him.		
Sequoia 1. Ring age, 2390 yr.	St-193A St-193B	2400 ± 75 2330 ± 65 Average 2360 ± 60
Sequoia 2. Ring age, 2000 yr.	St-213A St-213B	1845 ± 60 1910 ± 60 Average 1875 ± 55
Sequoia 3. Ring age, 2180 yr.	St-214A St-214B	2170 ± 65 2120 ± 65 Average 2145 ± 60
II. *Geologic, submorainic samples*		
Boliden, Västerbotten. Small pieces of wood from submorainic deposits found at Bjurliden, near Boliden. Submitted and described by Jan Lundqvist, Swedish Geological Survey (*13*).	St-19*	> 24,000
Bollnäs, Hälsingland. Pieces of wood in submorainic position. Described by B. E:son Halden (*14*). Submitted by C. Lundqvist, Swedish Geological Survey.	St-105	> 30,000
Kil, Värmland. Spruce wood (*Picea*) found at a depth of 30 m in the glaciofluvial deposits at Fryksta, north of Kil, in 1918. Described as Finiglacial by L. von Post (*15*). Submitted by G. Lundqvist.	St-113	> 30,000
Lund. Relics of tree roots (*Alnus*), found 200 m southwest of Råbyholm, in a vertical position in glacial sand underlain by northeastern moraine and partly covered by Baltic moraine. No roots were found at a higher level than 2 m below the surface. In spite of this, the sample evidently represents tree roots that grew down in post glacial time. In the superficial layers, the roots may have been destroyed by weathering without leaving any traces. Submitted by H. Möller, department of geology, University of Lund.	St-158	3930 ± 80
Lund. Relics of tree roots (*Alnus* or *Betula*), found at Måsvägen 18, in glacial sand covered by 1.3 m of Baltic moraine and underlain by northeastern moraine. The sample was taken 1.5 m below the surface. No traces of similar roots were seen in the covering Baltic moraine. In spite of this, the sample evidently represents post glacial tree roots. Submitted by H. Möller.	St-159	4060 ± 80
Oje Kapell, Kopparberg, Dalarna. Wooden log found under moraine at Oje Kapell. Submitted by G. Lundqvist, who has also described it (*16*).	St-11* St-181	> 24,000 > 40,000
Pilgrimsstad, Jämtland. Several relics of a mammoth in primary position were discovered in sand (*17*).		
A felty, 1-cm-thick bed of *Drepanocladus* sp. in a lacustrine sequence of strata under the thin ground moraine. Collected and submitted by O. Kulling, Swedish Geological Survey.	St-211	> 39,000
Plant sediments in connection with the mammoth find. Submitted by A. Martinsson, department of paleontology, University of Uppsala.	St-205	> 35,000
Sjöbo, Skåne. Peat on the Baltic moraine at Robertsdal, 20 km southeast of Sjöbo. The find was described as interstadial by H. Munthe (*18*), but is evidently post glacial. Submitted by G. Lundqvist.	St-212	10,980 ± 140
Vålbacken, Lake Storsjön, Jämtland. Plant remains at a depth of 16 m in ice lake sediments, between two moraines. Submitted and described by P. Torslund, Swedish Geological Survey (*19*).	St-206	> 37,000
III. *Prehistory of the Baltic Sea*		
Baltic Sea. Stump of fir found on the bottom of the sea at a depth of 43 m of water in the Baltic Sea south of Karlskrona, at lat. 56°00′N, long. 15°28′E. Submitted by B. Kullenberg, Oceanographic Institute, Gothenburg.	St-120	9100 ± 120
Baltic Sea. Stump of fir from the sea bed between Kåseberga and Bornholm at a depth of 35 to 37 m. The sample was submitted by Tage Nilsson, department of geology, University of Lund.	St-179	9330 ± 120

Description	Sample No.	Age
Fröjel, Gotland. Sample of the peat under the Ancylus beach at Gåistes (Göstas) in Fröjel. The sample was collected by H. Munthe in 1890. Submitted by G. Lundqvist.	St-174	9190 ± 130
Mölner, Klinte, Gotland. Peat below the Litorina beach. Collected by H. Munthe and submitted by G. Lundqvist.	St-185	9510 ± 140
Ramsås, Mönsterås, Småland. Peat sample below the Litorina beach. Collected by H. Munthe in 1901 and submitted by G. Lundqvist.	St-191	7030 ± 110
Stigstäde, Havdhem, Gotland. Oak wood found under Litorina sand by the late R. Sernander. From the Museum of the Swedish Geological Survey.	St-190	4355 ± 90
IV. *Geologic samples from peat bogs*		
A. *Datings of recurrence surfaces.* [A recurrence surface has been defined by Granlund (*20*) as a boundary between highly humified peat under less humified material, indicating a climatic change to a colder and wetter weather type.]		
Åstorp Moor, Nyed, Värmland. Peat samples submitted by Jan Lundqvist.		
A very thin recurrence surface 115 cm below the surface.	St-180	1225 ± 65
A recurrence surface 130 cm below the surface.	St-184	1225 ± 70
Blomskog, Värmland. Peat from a recurrence surface 295 to 300 cm below the surface in Blomma Mossen (Blomma Moor), Töcksmark. Submitted by G. Lundqvist.	St-167	2165 ± 65
Bråtenmossen, Gräsmark, Värmland. Peat from a recurrence surface 225 to 230 cm below the surface, found to be near the beginning of the *Picea* curve by pollen analysis. Submitted by G. Lundqvist.	St-178	2435 ± 70
Kindsjö, Bograngen, Värmland. Peat at a depth of 150 to 155 cm below the surface, at a recurrence surface about 35 cm below the level of the rational limit of the *Picea* curve. Submitted by G. Lundqvist.	St-176	2780 ± 70
Mosstakan, Arvika, Värmland. Peat sample collected at a recurrence surface 370 to 375 cm below the surface. Submitted by G. Lundqvist.	St-177	3010 ± 70
B. *Samples of special palynologic interest*		
Adak Mire, Malå, Västerbotten. Profile of peat at the open cut of the mine. The samples are intended to show the correlation between the pollen diagram and the C^{14} dates (*21*). Submitted by G. Lundqvist.		
Taken 5 cm below surface.	St-138	650 ± 70
Taken 35 cm below surface.	St-139	3000 ± 75
Taken 80 cm below surface.	St-140	5360 ± 80
Taken 130 cm below surface.	St-143	6940 ± 105
Taken 175 cm below surface.	St-144	8575 ± 120
Samples St-217, St-172, and St-173 were taken from peat bogs in the levels where the curve of *Alnus* starts in the pollen diagrams. The date for this point in the diagram from different parts of Sweden has great importance for reference. The samples were submitted by G. Wenner, department of geology, University of Stockholm.		
Degerfors, Närke. Gyttja 19 cm above the limit between clay and gyttja at the southern end of Lake Grytsjön. The actual level is 3.05 m below the present water level of the lake.	St-217	8880 ± 120
Hällesjö, Jämtland. The peat bog of Hällesjömyren, not far from the Ångerman River. Amblystogium peat collected 5 cm above the limit between gyttja and peat, which in the middle of the bog is situated 3.70 m below surface.	St-172	9100 ± 120
Långared, Västergötland. Peat collected 1.85 m below the bottom of a peat pit in the southern part of Långaredmossen Bog.	St-173	8500 ± 110
V. *Archeological samples from Lappland and neighboring provinces*		
Gäddede, Frostviken, Jämtland. Charcoal from the hearth of the Stone Age settlement T 61. No reliable archeological dating. Submitted by H. Hvarfner, Royal Office of National Antiquities, Stockholm,	St-187	3115 ± 75
Gällivare, Lappland. Charcoal from the bottom of a hunting pit filled with stones at Saivorova. No archeological dating. Submitted by H. Hvarfner.	St-152	1150 ± 65
Hotingsjön, Tåsjö, Ångermanland. A very interesting system of dwelling places. The samples were submitted by H. Hvarfner.		
Charcoal from a Stone Age settlement from which the oldest archeological find was dated to the Middle Neolithic.	St-188	5470 ± 100
Charcoal from another point, situated 100 m south of the former. The very great age is a little confusing at this locality, and a new sample will be collected as soon as possible.	St-198	7600 ± 110
Lake Storuman, Stensele, Lappland. Wooden remnants from the covering of a ritually buried bear. Submitted by H. Hvarfner.	St-207	215 ± 60
Lake Storuman, Stensele, Lappland. Charcoal from the hearth of a camp at the same place as sample St-207. Archeological finds of scanty fragments of bronze kettles make it reasonable to date this part of the camp to the end of the Viking period or the early (Scandinavian) Medieval. Submitted by H. Hvarfner.	St-208	1010 ± 60
Tärna, Västerbotten. Peat with sand lenses near Solberget. The sand was thrown up when a hunting pit was being dug. Submitted by G. Lundqvist.	St-110 St-131	1070 ± 80 1165 ± 85 Average 1115 ± 60
Tåsjö, Angermanland. Wood from the bottom of a hunting pit at Lake Rörström, Tåsjö. The pit is a part of a system of hunting pits, the existence of which has been historically fixed to about A.D. 1273 and also to the beginning of the 17th century. Submitted by H. Hvarfner.	St-170	450 ± 55
Trehörningsjö, Angermanland. Ancient ski found in 1907 at a depth of 60 cm in a peat bog in the parish of Trehörningsjö. The ski is of the Bothnian type, which, according to pollen analysis, together with several other finds, dates from the period 1500 B.C. to A.D. 1000. Submitted by E. Manker, Nordiska Museet, Stockholm.	St-161	2870 ± 70
VI. *Various Swedish archeological samples*		
Alvastra, Östergötland. The Neolithic dwelling place in the former swamp at Dags Moor, Alvastra. Archeological dating, 2000 to 3000 B.C. Submitted by L. Kaelas, Museum of National Antiquities, Stockholm.		
Wooden pile from the pilework.	St-9*	4210 ± 150
Peat from the corresponding culture layer.	St-15	4090 ± 230 Average 4180 ± 130
Angelsta, Småland. Flax found in a moor at Hedenstorp, together with several wooden artifacts. No archeological dating.	St-128	435 ± 85

Description	Sample No.	Age
Submitted by A. Oldeberg, Museum of National Antiquities.		
Badelunda, Västerås. Wood from a grave with rich gold findings in Badelunda, city of Västerås. Archeologically dated to the beginning of the 4th century A.D. Submitted by D. Selling, Museum of National Antiquities.	St-148	1805 ± 70
Badelunda, Västerås. Wood from ship grave 75 in Badelunda. Archeological dating, latter part of 9th century A.D. Submitted by B. Schönbeck, Museum of National Antiquities.	St-150	1225 ± 65
Kattegat. Wood from a ship, found by trawling at 75-m depth in the Kattegat, 40 nautical miles northeast of Christiansö. No archeological dating. Submitted by Trelleborg's Museum.	St-27	650 ± 150
Falsterbo, Skåne. Cattle hair oakum from a ship found in 1932 in the southern Baltic Sea outside Falsterbo. Palynologically and archeologically suggested to come from early Medieval. Submitted by J. Tandberg, Swedish C^{14} Board.	St-137	850 ± 70
Falun. Three samples in a series that will be used to date the beginning of mining at Falun Copper Mines. Submitted by Stora Kopparbergs Bergslag, Ltd.		
Uppermost peat layer below the mineral waste northwest of the opening.	St-163	1105 ± 60
Piece of wood in the mineral waste 10 cm above the peat layer.	St-165	690 ± 55
Wooden branches on the surface of the peat under the mineral waste.	St-166	875 ± 60
Galtabäck, near Varberg, Halland. Cattle hair oakum from a ship, excavated in 1928. Previous geologic and archeological datings are controversial, both 5th to 7th centuries and 12th to 13th centuries A.D. having been proposed. Submitted by C.-A. Moberg, Gothenburg Archaeological Museum.	St-204	880 ± 65
Hasslöv, Halland. Resin packing from a hexagonal stone cist containing bronze finds. Museum of National Antiquities. No. 3987 : 5, c. Archeologically dated to the later part of the IV period of the Bronze Age (about 800 B.C.). Submitted by A. Oldeberg.	St-201	2810 ± 75
Högom, Selånger, Medelpad. Charred wood from a tumulus containing a richly furnished warrior's grave. Archeologically dated to about A.D. 500. Submitted by D. Selling, Museum of National Antiquities.	St-186	1570 ± 70
Hylletofta, Småland. Wooden log with runic carvings found in the floor at the altar in the Roman church of Hylletofta. Archeological dating uncertain. Submitted by P.-O. Westlund, Museum of National Antiquities.	St-168	585 ± 60
Ljungsbro, Östergötland. Gyttja from the "Hell Marsh" (Helveteskärr), at 0.9-m depth where a primitive-looking male human skull was found, showing a cut from a stone axe. Pollen analysis places the sample just above Granlund's recurrence surface V, about 2000 B.C. (*20*). Submitted by N.-G. Gejvall, Museum of National Antiquities.	St-109	3750 ± 100
Stenåsa, Öland. Part of a wooden log (oak?) found under the floor of the apse in the Roman church of Stenåsa. Submitted by Iwar Andersson, Museum of National Antiquities. The sample was in a rather poor condition, and it was not possible to determine how far from the bark the actual rings had been located.	St-135	675 ± 75
Tingstäde Träsk, Gotland. The swamp of Tingstäde contains the remnants of a large wooden fortification called Bulverket. It consisted of a central part of heavier piles and a palisade of thinner ones. The pile-work fortifications are architecturally and archeologically dated to about A.D. 1000, but have been the subject of many discussions.		
Outer tree rings of a log from a raft. Submitted by G. Lundqvist from the collections of the Swedish Geological Survey.	St-10	790 ± 120
Plank from the palisade, tree rings near the bark. Submitted by G. Arwidsson, department of archeology, University of Stockholm.	St-125	960 ± 60
Central tree rings of a wooden prop about 35 rings thick, from the central part. Collected in the autumn 1955 and sent in by G. Arwidsson.	St-118	850 ± 70
Valö, Uppland. Heavy deal plank carved in the shape of a dragon's head. The find is stylistically dated to the end of the 8th or the 9th century A.D. by W. Holmquist (*22*), who also submitted the sample.	St-122	1140 ± 65
VII. *Archeological samples from other countries*		
Erimi, Cyprus. Charcoal from the Erimi culture containing artifacts, approximately dating between 3400 and 3000 yr B.C. (*23*). Submitted by P. Dikaios, Cypus Museum, Nicosia.		
Layer No. 2.	St-202	4630 ± 80
Layer No. 3.	St-203	4540 ± 80
Beaumont, Cotentin, France. Charcoal from large wall constructions of uncertain age at Le Hague-Dike. Described and submitted by H. Arbman (*24*), University of Lund Historical Museum.		
Cut I 1951 from the second layer of the uppermost section.	St-153	2855 ± 75
Cut I 1951 from the second layer of deepest section.	St-146	2710 ± 65
Rang Mahal, Rajputana, India. Charcoal from a pit in the uppermost layers of a mound. Archeologically and geologically dated to about 500 A.D. Submitted by H. Arbman.	St-192	1525 ± 70
Teotihuacán, Mexico valley. Charcoal from a cremation under large ruin complex Tlamimilolpan, Teotihuacán. Excavated in 1935 under the nethermost of three concretelike, intact floors. Artifacts from Maya culture under the same floor point to a date A.D. 278 to 593 (Goodman-Martínez-Thompson correlation) or A.D. 18 to 333 (Spinden's correlation). Submitted by S. Linné, Ethnographical Museum, Stockholm.	St-162	1720 ± 65

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H. R. Morgan, Astronomer

The death of Herbert Rollo Morgan at his home in Washington, D.C., 11 June 1957, brought to a close a life of sincere devotion to his family and to astronomy. His last illness extended over a period of 2 months; however, he had suffered considerably, prior to this, from frequent spells of bad health during the last few years.

He was the son of Henry D. and Olive Smith Morgan and was born on 21 March 1875, near Medford, Minnesota. By the time he was 9, the rigors of the Minnesota winters proved to be so trying to his health, which was somewhat impaired by an asthmatic condition, that his mother sought relief for him in the milder climate of Tennessee, where he grew up and received his early education.

He received his A.B. and Ph.D. degrees from the University of Virginia in 1899 and 1901, respectively. While a student at the university, he held one of the prized Vanderbilt fellowships at the Leander McCormick Observatory. During the last year of his graduate work he commenced teaching mathematics at the Pantops Academy and continued there until he received an appointment to the U.S. Naval Observatory as a computer, in 1901. Four years later he decided to try teaching again and accepted a professorship in astronomy and mathematics at Pritchett College, where he also served as director of the Morrison Observatory.

In 1907 he returned to the Naval Observatory as assistant astronomer on the staff of the 9-inch transit circle. In 1913 he was placed in charge of the instrument and at once began a series of fundamental observations which lasted until 1926. The catalog of final results for this program is a typical example of the thoroughness and painstaking care which he devoted not only to the major problems arising in his work but to those small details as well, which, if not properly attended to, sometimes ruin an otherwise excellently planned project. This program was followed by two others—the first, a differential determination of the positions of the reference stars for the Yale zone – 10° to – 20°, and the second, another fundamental program which was not entirely completed at the time of his retirement in 1944.

Retirement to Morgan merely meant more time for his researches. These he carried on privately for a while and later, from 1947 to 1950, as research associate of Yale University. Even up to the time of his last illness he was busily engaged in computing the proper motions of a group of O and B spectral type stars.

Morgan's principal contributions were in the field of fundamental astronomy. His philosophy that good observations should be put to use, combined with a thorough knowledge of how to use them, brought forth during his life many papers and publications of the first order of importance. His earliest papers were concerned mainly with the orbits of comets and asteroids. These were followed by a number of articles in which he ably treated problems and questions that come up during a transit circle program. By the time he reached his middle years his attention began to focus on the fundamental quantities upon which astronomy is built. He analyzed hundreds of thousands of observations for the purpose of obtaining a better knowledge of the position of the equator, the motion of the equinox, the constants of aberration and nutation, the motion of the perihelion and corrections to the orbital elements of the planets. In his late years he compiled his N30 catalog, in which are given the definitive positions and motions of 5268 stars. The fundamental coordinate system established by the N30 and the proper motions based on it have formed the starting point for several recent investigations, among which may be mentioned a correction to the precession, the luminosities of the nearest Cepheids, and other researches related to the structure of the galaxy. Without doubt, the N30 and its associated papers represent the greatest achievement of his career.

Morgan's capacity in his field of specialization won him many recognitions. In 1952 the National Academy of Sciences awarded him the Watson medal for his contribution to fundamental astronomy and, by invitation, he presented a report on the astronomical constants at the Paris conference in 1950. He also presented a discussion of the basis on which the reference system of stellar positions rests at the symposium on the Fundamental Properties of the Galactic System conducted by the New York Academy of Sciences in 1941.

He was a member of the National Research Council, the Washington Academy of Sciences, and the Geophysical Union. He served as vice president of the American Astronomical Society from 1940 to 1942 and as chairman of Section D of the American Association for the Advancement of Science in 1936. He attended his first meeting of the International Astronomical Union in 1928 and served as president of the commission on meridian astronomy of that organization from 1938 to 1948. He was an associate editor of the *Astronomical Journal* from 1942 to 1948.

A humble man, Morgan conducted his life in a very unpretentious manner. His high sense of honor made personal dealings with him a pleasure. His associates at the Naval Observatory and his colleagues in the astronomical world respected him, and will remember him, as a valued friend and faithful worker.

F. P. Scott

U.S. Naval Observatory, Washington, D.C.

R. M. Yerkes, Psychobiologist

Robert Mearns Yerkes, one of America's greatest psychologists or psychobiologists, as he preferred to be called, was born in Bucks County, Pennsylvania, 26 May 1876, and died in New Haven, Connecticut, 3 February 1956.

Yerkes' life illustrates the power, in a scientific career, of a fruitful idea. He reported that when he was still a graduate student at Harvard, he suddenly became convinced that what was needed to unlock the complex problems of human and animal behavior was a research institute for the comparative study of mammals and man, with special reference to the great apes. The idea for this program occurred to him in 1900. By laboring for more than half a century, and in spite of great financial difficulties, he was able to transform this important plan into an effective reality.

After taking his undergraduate degree at Ursinus College, he went to Harvard in 1897. He stayed there as a graduate student and faculty member for 20 scientifically valuable years. During this period he organized and developed work in animal or comparative psychology at Harvard. While in Cambridge he also applied the techniques of the biologically trained psychologist to a number of applied problems in human psychology. For 5 years, for example, he gave half of his time to psychological service and research in the psychopathic department of the Boston State Hospital. Here his famous point scale for measuring mental ability was developed.

In 1917 he accepted an invitation to go to the University of Minnesota to organize, in a new and enlarged way, its work in all areas of psychology. He at once began recruiting an outstanding staff for the department. But he himself was destined never to take up residence in Minnesota. Before he could begin work there, World War I intervened. At that time he was president of the American Psychological Association, and, greatly to the advantage of the nation and of the psychological profession, he at once offered to mobilize American psychologists for the war effort.

As a result of the work that he initiated, more than 400 psychologists and trained assistants gave intelligence tests to 1,726,966 inductees. The results of this first large-scale use of group tests were later issued, under Yerkes' direction, as a monumental volume, *Psychological Examining in the United States Army*," published by the National Academy of Sciences in 1921. This book did much to set the pattern of applied psychological work for the period between the two world wars.

At the end of hostilities he was anxious to proceed with his plans for the development of an institute for comparative behavior research. But he was prevailed on to stay in Washington to assist in the establishment of the many peacetime programs of the new National Research Council. During this period he demonstrated his great ability as an organizer and as a creative worker in a broad range of fields related to scientific manpower policy and utilization. Even today it is hard to find any area of scientific manpower work, such as the analytical listing of scientists, the development of fellowship programs, or the recording of the topics and scope of research in progress, that was not planned at this time by Yerkes.

At length, in 1924, he did return to academic work as a professor in the new Institute of Psychology at Yale. From this time on, his research and his publications more and more mark the development of his great motivating idea for an institute for the comparative study of behavior. In 1929, with the expert collaboration of his able wife, Ada W. Yerkes, he published *The Great Apes: a Study of Anthropoid Life*. This volume of more than 650 pages showed, for the first time in a complete way, the scientific world the importance of comparative anthropoid studies.

In 1930, with the assistance of Yale University and the Rockefeller Foundation, Yerkes began the erection of the basic buildings of the Yale Laboratories of Primate Biology at Orange Park, Florida. This unique station for the study of the great apes was renamed the Yerkes Laboratories of Primate Biology at the time of its founder's retirement in 1942.

The location of this laboratory on Florida's St. Johns River, about 15 miles from the city of Jacksonville, was based on a careful study of climate, records of storms, and all other environmental matters relevant to the establishment of a breeding and study colony in which the great apes could live under satisfactory and natural conditions. A list of the names of the scientists who have worked and been trained at this station and a study of the approximately 400 research papers that have been issued there attest to the fruitfulness of Yerkes' original idea that led to the establishment of the laboratory.

During World War II, Yerkes again offered his talents as an organizer to the service of the nation. At this time he had an opportunity to note how unfortunate for the country had been the abandonment of some of the programs that he had started during World War I and that he had attempted to foster, at the National Research Council, in the period of demobilization and peace following that conflict. Because of his broad experience in national affairs, Yerkes devoted much of his time during World War II, and after its close, to developing plans by means of which civilian scientists and regular military leaders could be kept in effective contact with each other in the solution of the ever new problems that result from progress in the techniques used in the defense of the nation.

There is a deep symbolism in the fact that Yerkes' last paper was entitled "The biologist's point of view." In all his work this had indeed been his approach to the problems of behavior and of mind. This way of understanding psychology was seen in his own research, in the investigations of his students, and in the unique laboratory that he brought into being. As a result of his wisdom and energy, many positive forward steps have been made possible in the scientific understanding of human and animal behavior. He was a pioneer who had, to a rare degree, the energy and diligence necessary to transform original ideas into effective accomplishment.

LEONARD CARMICHAEL
Smithsonian Institution,
Washington, D.C.

News of Science

IAEA First-Year Program

The Preparatory Commission of the International Atomic Energy Agency recently released a report proposing a program for the first year of IAEA's operation. The report will be considered at the first general conference of the agency, which will open in Vienna on 1 Oct. In addition to the report of the Preparatory Commission, the conference will consider a variety of other recommendations made by the commission concerning the relationship of the agency to the United Nations and to other international organizations, the headquarters of the agency, and a number of recommendations concerning structure and administration.

The basic objective of the agency as defined in its statute is to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world." The Preparatory Commission's report recognizes that one of the first ways in which the agency can attempt to meet this objective is by assisting its members "to acquire the knowledge and skills to make full use of the applications of radiation and radioisotopes for scientific research, and to . . . agriculture, industry, and medicine."

The commission recommends that the agency take early action to stimulate the flow of scientific and technical information among its members. While welcoming the removal of classification restrictions during the last year or two, the commission considers that the agency can offer a unique service by providing a central pool of information and by keeping its members informed of the latest developments in the nuclear field.

The commission emphasizes that from its inception the agency "will be faced with problems created by the world-wide shortage of trained scientific and technical personnel." It recommends, therefore, that the agency take immediate steps to assist the training of nuclear specialists, particularly in the underdeveloped countries, and expresses the hope that member states will from the outset place at the disposal of the agency training and research facilities, particularly where reactors already exist. The commission suggests the establishment of a special program for promoting the construction of a limited number of research or power reactors, so located as to give "the maximum benefit to the largest possible number of member states."

The report recommends that the budget for the first year of the agency be $4,089,000 and that a working capital fund of $2 million be established. In addition, it is proposed that states that are members of the agency make voluntary contributions totaling $250,000 for the establishment of training programs for nuclear specialists, particularly in the less-developed countries.

SEATO Fellowships

Research fellowships for nationals of member countries are now being offered by the Southeast Asia Treaty Organization under its cultural relations program. The grants, for research primarily in SEATO countries, seek to encourage study of "such social, economic, political, cultural, scientific and educational problems as give insight into the present needs and future development of Southeast Asia and the Southwest Pacific."

The grants are for from 4 to 10 months and provide a $400 monthly allowance and air transportation. Announcement of the final awards, which are to be made by an international SEATO committee, is expected in December. U.S. citizens should apply *not later than 15 Oct. 1957* to the Committee on International Exchange of Persons, Conference Board of Associated Research Councils, 2101 Constitution Ave., NW, Washington, D.C.

Submarine Mountain Range

A new undersea mountain range has been discovered north of Point Barrow, Alaska, by a team of geophysicists from Columbia University's Lamont Geological Observatory. The group, which is engaged in research for the International Geophysical Year, is stationed on an Arctic ice pack that is drifting toward the North Pole. The work is sponsored by the IGY Committee of the National Academy of Sciences and the Air Force Cambridge Research Center.

Maurice J. Davidson, leader of the expedition, has radioed that there is every indication that this major submarine range parallels the great Lamonosov ridge in the central Arctic. This latter ridge extends from Greenland across the Arctic Ocean toward the New Siberian Islands and has been explored by Soviet scientists and by American scientists on T-3, the floating ice island.

The geophysicists have reported that since first soundings were taken at 82°15′N and 165°10′W all results had indicated water depths of about 3000 meters, or nearly 10,000 feet. Recently, however, the station, which has been moving steadily, floated over a "topographic feature" with depths as shallow as 1515 meters, or 4971 feet, at 83°51.5′N and 168°43′W. This indicates a submarine mountain range that rises at least 5000 feet above the ocean floor. It was not possible for the investigators to obtain further details on the length or width of the range.

The geophysicists also reported that several cores of ocean-bottom sediments have been obtained by the expedition. One of these cores is perhaps the longest ever obtained in the Arctic Ocean. They will be brought back to the Lamont Geological Observatory for analysis.

High-School Science Enrollments Rise for First Time since 1910

The U.S. Office of Education reports that a recent study of high-school enrollments in science and mathematics, to be published in full in a few months, shows that last fall there was a small increase in the percentage of students enrolled in mathematics and science courses. This is the first such increase since 1910. Until last fall, the percentages had been generally on the decline. However, despite the previous percentage declines, the total number of students enrolled in these courses has increased steadily and is now the highest in the nation's history.

The Office of Education also reports that more and more schools have been offering courses in science and mathematics. The percentage of public high schools providing courses in chemistry or physics to 12th-grade students rose from 77 percent in 1954 to 82 percent last year. Schools offering plane geometry courses to 10th-grade students rose from 78 percent to 81 percent.

The study showed that the percentage of high-school students taking algebra

decreased from nearly 56.9 percent in 1910 to a low of 24.6 percent in 1952, then increased to 28.7 percent in 1956. However, the total number of students enrolled in this subject increased from about 500,000 in 1910 to more than 2 million in 1956.

Wide regional variations in enrollments in science and mathematics were found in 1956, the base year for the recent study. For example, 90 percent of the 10th-grade students in the South Atlantic region study biology, as compared with only 65 percent in the Pacific Coast states. In one region 27.9 percent of the students studied intermediate algebra, as compared with 3.8 percent in another.

Many small high schools do not offer advanced science or advanced mathematics courses. Although they enroll a relatively small proportion of the total high-school students, approximately 100,000 high-school seniors attend schools that do not offer advanced mathematics.

Visiting Scientists Program

The American Association of Physics Teachers and the American Institute of Physics are jointly sponsoring a program of visiting scientists for 1957–58. Supported by a grant from the National Science Foundation, the program will provide opportunities for the faculty and students in colleges and universities lacking extensive research facilities to meet well-known physicists informally and to hear them discuss their research interests. A few high schools will also be included in the program.

This activity is under the direction of the AAPT Committee on the Program of Visiting Scientists, whose chairman is J. W. Buchta of the University of Minnesota. Inquiries should be directed to W. C. Kelly, American Institute of Physics, 335 E. 45 St., New York 17, N.Y.

Nova Scotia Centre for Geological Sciences

An unusual international educational program celebrated its tenth anniversary on 30 Aug. with the closing exercises of the Massachusetts Institute of Technology Summer School of Geology at Antigonish, Nova Scotia. Sponsored jointly by the M.I.T. department of geology and geophysics and the Province of Nova Scotia, this school has helped educate some 350 young Canadian and U.S. geologists.

This outstanding example of international cooperation in education functions as follows. Several professors from M.I.T. and from Nova Scotia universities instruct a group of 25 to 30 students each summer in field training in geology and associated sciences at the Nova Scotia Centre for Geological Sciences at Crystal Cliffs. The project, which is administered by M.I.T., also carries on a program of student thesis work and staff research throughout the Province of Nova Scotia.

The province, largely through the Department of Mines and to some extent through the Nova Scotia Research Foundation, provides lodging, food, and transportation for the students and staff of the school. In several cases, the province has also provided grants and transportation assistance to students working on theses.

Students from four Nova Scotia schools—Acadia University, Dalhousie University, Nova Scotia Technical College, and St. Francis Xavier University—have an equal opportunity with M.I.T. students to participate in the instructional program and in the thesis work of the school. Students from other maritime colleges and from other schools in the United States are admitted as far as facilities permit.

Sixteen American schools besides M.I.T. have sent students to the program, with Yale University having sent the most. These U.S. students have come from 36 of the 48 states. In addition, foreign students from every continent of the globe have also participated in the program.

The curriculum of the school covers a period of 10 weeks, part of which is devoted to practical field mapping and detailed studies related to the natural resources of Nova Scotia. In the past 10 years, students have set up and occupied more than 50 camp sites for their field work.

These field studies have been chiefly devoted to unsolved problems, and many of the reports on stratigraphic and structural geology have had a bearing on natural resources. Such reports on problems of an economic or practical nature have included studies dealing with gold, copper, iron, cobalt, uranium, and coal. A number of these studies have been published by the Nova Scotia Department of Mines.

This international cooperative venture in geologic instruction and research was initiated by Walter L. Whitehead of M.I.T., Donald J. MacNeil of St. Francis Xavier University in Antigonish, and Harold D. Smith of the Nova Scotia Research Foundation. It has been sponsored and supported from the beginning by the Nova Scotia Department of Mines. Additional assistance has been given by the Nova Scotia Research Foundation, the Dominion Coal Company, and the Geological Survey of Canada.

Marshall Island Fallout Report

The Atomic Energy Commission has announced publication of *Radioactive Contamination of Certain Areas of the Pacific from Nuclear Tests—a Summary of the Data from the Radiological Surveys and Medical Examinations.* This report brings together the principal data on environmental contamination from the radioactive fallout following the 1 Mar. 1954 thermonuclear detonation at the Eniwetok Proving Ground. It collates ten radiological surveys made in the Pacific by the Applied Fisheries Laboratory of the University of Washington, U.S. Naval Radiological Defense Laboratory, Health and Safety Laboratory at the New York Operations Office of the AEC, and the Office of Naval Research. The report also contains pertinent excerpts of the findings of American medical teams who examined the exposed Marshallese. The report may be obtained for 50 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

Cleveland Engineering Center

The Cleveland Engineering and Scientific Center, Cleveland, Ohio, is now under construction. A cornerstone ceremony was recently held for the $1,525,000 building, which is scheduled to open next spring as headquarters for 13,000 engineers, scientists, and technical experts in the Cleveland area. The structure will have a main section of two stories and a five-story tower. In addition to the Cleveland Engineering Society, 52 member organizations of the Cleveland Technical Societies Council will use the building.

International Abstracts of Biological Sciences

Last October it was announced in *Nature* (**128**, 726) that it was the intention of the Council of Biological and Medical Abstracts Limited to change the name of *British Abstracts of Medical Sciences* to *International Abstracts of Biological Sciences.* This change has now occurred, and it emphasizes two important developments in the character of the journal: the abstracts now cover a wider range of subjects and they also cover the Russian literature. The inclusion of subjects not previously covered has been promoted by the appointment to the council of representatives from the Society of Experimental Biology.

A variety of other improvements have also been incorporated, and *International Abstracts of Biological Sciences*

now provides a comprehensive abstracting service for experimental and biochemical aspects of biology. The journal is published by Pergamon Press for the council on a nonprofit basis. Suggestions for improvements and offers of help in abstracting (especially from those with a knowledge of Russian) are always welcome and may be addressed to the Editorial Offices, International Abstracts of Biological Sciences, Pergamon Press Ltd., 4–5, Fitzroy Square, London, W.1., England.

Manhattan's Bedrock

Headed by J. Laurence Kulp, associate professor of geology, a group of geochemists from Columbia University's Lamont Geological Observatory recently investigated the age of New York City's bedrock. The research team was able to measure the ratio of potassium to argon (its decay product) in the rock, and their findings support the view that the Manhattan schist is some 380 million years old.

This conclusion is expected to end a long-standing controversy among geologists, some of whom have maintained that the Manhatton rock is Precambrian, up to 1700 million years old. Walter H. Bucher, Newberry professor emeritus of geology at Columbia and former president of the Geological Society of America, has argued that it is much younger.

Nuclear Chemical Company

The Nuclear Chemical Company, Chicago, Ill., is a new company that will manufacture and supply organic compounds tagged with radioactive carbon, hydrogen, phosphorus, and sulfur. Services offered by the new company include the performance of special syntheses and consultations and research involving applications of radiochemical techniques.

Bernard Wolnak, who is president of Mid-West Laboratories, will also head this new organization. Earl L. Whittaker, radiological chemist who was formerly associated with Nuclear-Chicago Corporation, will be in charge of laboratory operations.

Ultraviolet Spectral Data

Organic Electronic Spectral Data, Inc., of Silver Spring, Md., is preparing what is perhaps the most comprehensive collection of ultraviolet spectral data ever attempted. H. E. Ungnade of Los Alamos Scientific Laboratory, president of the nonprofit corporation, estimates that the collection may include descriptions of as many as 50,000 ultraviolet absorption spectra of organic compounds. Purpose of the project is to make available in one definitive reference a majority of such data published since the onset of the photoelectric era. To aid the work, Beckman Instruments, Inc., recently made a $1000 contribution.

Forty scientists from government, industry, and universities are cooperating in the venture, and the material is being abstracted from 65 journals in eight languages. Since the start of the project early this year, more than 21,000 spectra have been collected. The first two-volume set of *Organic Electronic Spectral Data*, which will cover the literature from 1946 to 1955, will be published next year by Interscience Publishers, New York, under the editorship of Ungnade and Mortimer Kamlet of the U.S. Naval Ordnance Laboratory, White Oak, Md.

Leukemia Fellowship in Argentina

Fundaleu, a leukemia foundation in Argentina, has announced the Silvina Estrada de Acevedo fellowship for research in experimental leukemia. This award has been established by Don Horacio Acevedo in memory of his wife. It is open to a scientist from any part of the world who has already been conducting research in the field. The fellowship recipient will work at the Department of Experimental Leukemia, Blood Research Institute, National Academy of Medicine, for a year, beginning 1 Feb. 1958. The grant may be extended for a year. Applications, which must include personal data and a project outline, should be forwarded *not later than 30 Nov.* to: Fundaleu, Instituto de Investigaciones Hematologicas, Academia Nacional de Medicina, Melo 3081, Buenos Aires, Argentina.

Pharmaceutical Research Information

Current Contents of Pharmaceutical Publications is a new weekly designed to fill the pharmaceutical industry's need for current research information. Research in human and veterinary medicine, public health, pharmacology, and synthetic chemistry will be covered. Organizations subscribing to the *Current Contents* service receive multiple copies of a weekly pocket-size booklet containing photographic reproductions of the current or advance tables of contents of nearly 250 periodicals.

Two additional features available to subscribers to the *Current Contents* service are a reprint expediting service and a procurement service for purchasing single copies of individual journals. For a list of the journals covered, specimen copies, and any additional information write to: Eugene Garfield Associates, 1523 Spring Garden St., Philadelphia, Pa.

Arkansas Technology Institute

The University of Arkansas is planning construction of its first Graduate Institute of Technology at Little Rock. Nine leading scientists and educators met 29 July at Winthrop Rockefeller's Winrock Farm in Arkansas to discuss the institute's buildings, curriculum, and staff. Rockefeller, as chairman of the Arkansas Industrial Development Commission, is working closely with the university in organizing the school.

The men attending the conference were A. V. Astin, director, National Bureau of Standards, Washington, D.C.; Lee A. DuBridge, president, California Institute of Technology; Clark D. Goodman, assistant director for technical operations, Division of Reactor Developments, U.S. Atomic Energy Commission; George W. Irving, deputy administrator, Agricultural Research Service, U.S. Department of Agriculture; Marvin J. Kelley, president, Bell Telephone Laboratories; Alan T. Waterman, director, National Science Foundation; Clyde Williams, president, Battelle Memorial Institute; R. M. Zabel, engineering manager, Westinghouse Electric Corporation; and Joseph R. Bransford, vice president, Telephone and Installation Division, Western Electric Company.

Arkansas is engaged in a campaign to get new industries, and the 1957 legislature appropriated $600,000 for the 1957–59 biennium to build an institute for basic and applied research in the physical sciences. Out of the Winrock discussion came the conclusion that the school should be primarily an educational institution closely connected with the university, whose main campus is located at Fayetteville. It was agreed that the institute should concentrate on the pure sciences and not be an applied research center, that applied research to encourage location of new industries would follow in the natural evolution of the institute.

It was suggested that the new institute provide work to the master's level, building on top of the usual engineering degree and giving emphasis to the basic sciences and mathematics. A doctoral program may be considered in later years.

An advisory council set up as a steering group will hold meetings in the near future to select a director and continue organizational planning. Several sites for the institute are being considered in the Little Rock area.

Ortho and Hartman Awards

The American Society for the Study of Sterility has announced the 1958 Ortho and Carl G. Hartman grants-in-aid, each of which amounts to $500. Applications for these two awards should be sent *by 30 Nov.* to the chairman of the society's Research Correlating Committee, Dr. S. Leon Israel, 2116 Spruce St., Philadelphia 3, Pa. No application will be considered unless it is accompanied by three copies of a brief outline of the research project for which aid is being requested.

Cytoanalyzer

A newly developed cytoanalyzer, an electronic optical machine that can scan a vaginal smear slide in less than 1/5 millisecond, has been installed by the National Cancer Institute at the University of Tennessee Medical School in Memphis. Potentialities of the new cell-examination method for detection of uterine cancer have already been demonstrated. First examination of 108,000 women led to discovery of about 800 cases, about half of them in the preinvasive stage.

Valid Zoological Names

The International Trust for Zoological Nomenclature has announced that arrangements have been made for the immediate publication in book form of the first installment of each of the "Official Lists" of valid zoological names and of the corresponding "Official Indexes" of rejected and invalid names, together with the first installments of the official lists of works approved as available for zoological nomenclature and of the official index of rejected and invalid works. The categories of names covered by these lists and indexes range from specific names to ordinal names. The total number of entries contained in the installments now to be published is about 5000.

The first of these lists, that related to generic names, was established by the ninth International Congress of Zoology, Monaco, 1913, while the most recent were brought into existence by the 14th congress at Copenhagen in 1953. The entries made on these lists and indexes have been promulgated from time to time by the International Commission on Zoological Nomenclature in individual "Opinions" and "Directions," but, owing to the large number of documents, it has become increasingly difficult for specialists to ascertain what names have so far been registered under this system.

This difficulty will completely disappear on publication of the installments now in press, each of which will be supplied both with a full alphabetical index and also with alphabetical indexes arranged by major groups. The groups so selected will usually be classes, but, in the case of large classes containing well-recognized orders, these supplementary indexes will be on an ordinal basis.

These official lists and official indexes constitute the principal instrument devised to promote stability in zoological nomenclature and will be indispensable to all specialists engaged in taxonomic work in zoology and paleontology. Inquiries about these publications should be addressed to the International Trust for Zoological Nomenclature at its Publications Office, 41 Queen's Gate, London W.W.7, England.

System for Patent Searching

The U.S. Patent Office has reported that a newly developed punch-card system for mechanically searching files of patents has cut examination time 80 percent and made possible what may become a significant advance for the drug manufacturing industry. The new method was used to help examiners determine whether patents could be granted to 64 patent applications involving steroids. This required the inspection of more than 2000 existing patents to uncover any subject matter related to the pending applications. Results showed that one examiner could do the work of five in the same period of time and with a higher degree of accuracy.

On the basis of this successful operation, the Patent Office has proposed to officials of the American Drug Manufacturers Association that industry, together with interested organizations, individuals, universities, and libraries, cooperate to expand the file of cards to include steroid material from all technical publications. Data would be analyzed, coded, and punched into the master file along with the patent information already there. Anyone needing the information could obtain the entire file at the nominal cost of reproducing the punched cards.

Robert C. Watson, commissioner of patents, and Karl Bambach, executive vice president of ADMA, have urged that those most interested cooperate on the project in view of the continuing large expansion of the steroid chemistry field. An ADMA committee appointed to consider industrial phases of the project met with Patent Office representatives this month during the American Chemical Society's national conference in New York.

Fossil Vertebrate Collection

The Los Angeles County Museum recently received from California Institute of Technology its entire reference and exhibit collection of fossil vertebrates. This brings together the two important collections so thoroughly documented by the late Chester Stock and his students: the C.I.T. collection accumulated during the past 23 years and the museum's Rancho La Brea fossils. With the addition of the institute collection, which contains more than 50,000 specimens from at least 500 separate localities in North America, the museum has become one of the most important vertebrate paleontological centers in western North America.

The greater part of the research collection is available for use by interested research workers. Most of the fine exhibit specimens (such as those from California and Mexico) must wait their turn for display until the museum fulfills its intent to provide more exhibit space. For the present it is possible to place on display the complete mounted skeleton of the California Cretaceous Plesiosaur, *Morenosaurus stocki,* and the original skeleton of the dawn horse, *Eohippus borealis,* from Big Horn Basin in Wyoming. Theodore Downs, curator of vertebrate paleontology, will be in charge of the collections under the supervision of Hildegarde Howard, chief curator of science.

Scientists in the News

GERARD P. KUIPER, professor of astronomy at the University of Chicago, has been named chairman of the department of astronomy. Kuiper also will be director of the university's Yerkes Observatory at Williams Bay, Wis., and the McDonald Observatory at Fort Davis, Tex., which the university operates under a joint agreement with the University of Texas.

He succeeds BENGT G. STROMGREN, Sewell L. Avery distinguished service professor of astronomy, who has been chairman of the department and director of both observatories since 1951. Stromgren has accepted an appointment to the Institute for Advanced Study, Princeton, N.J.

BEN R. BURMESTER has received the Borden award for his work since 1950 on visceral lymphomatosis, a poultry disease that can be compared with Hodgkins disease in human beings. It is estimated that visceral lymphomatosis costs the industry and consumers $70 million a year.

Burmester, who is a senior biologist in the regional poultry research laboratory

of the U.S. Department of Agriculture and an associate professor at Michigan State University, has developed a vaccine for immunization of chickens which has proved effective experimentally but which has not yet been made available commercially.

K. E. BULLEN, chairman of the Australian National Committee for the International Geophysical Year, will speak to 16 local sections of the Society of Exploration Geophysicists on a tour that will cover most of the United States and part of Canada during September and October. For information about his schedule, write to the chairman of the SEG's Distinguished Lectures Committee, Peter Dehlinger, College Station, Tex.

L. D. HERRING, dental surgeon and president of the Southern Chapter of the AAAS at Raleigh, N.C., has just returned from Havana, Cuba, where he was made an honorary member of the Cuban Society of Public Health and honorary member of the Cuban Society of Tropical Medicine and Biology. Herring will return to Havana on 3 Dec. to receive the Cuban decoration of the National Order of Merit "Carlos J. Finlay" in the grade of officer.

ROBERT A. MOORE, vice chancellor of the health professions at the University of Pittsburgh, has been appointed president of the Downstate Medical Center of the State University of New York and dean of the center's College of Medicine.

He succeeds HOWARD W. POTTER, who will retire from the deanship on 1 Oct. Potter, professor of psychiatry at the college since 1943, will continue in that capacity.

WARREN E. WILSON has been named acting president of Pratt Institute to succeed FRANCIS H. HORN, who resigned in June. Wilson joined Pratt as dean of the engineering school last September; he had been at Pennsylvania State University, where he was George Westinghouse professor of engineering education.

NICOLAR KURTI of Oxford University, England, received the $1000 Fritz London memorial award at the University of Wisconsin during the recent International Conference on Low Temperature Physics and Chemistry. He was honored for his outstanding research contributions in the field of low-temperature physics. The award is provided by Arthur D. Little, Inc., Cambridge, Mass., as a memorial to the late Fritz London of Duke University, a noted physicist in the field.

DANIEL G. MAZUR has been appointed manager, Vanguard Operations Group, at Patrick Air Force Base, Fla., where he will supervise the Navy's part of the operations at Patrick for the earth satellite program. Mazur, an electronic engineer who has been with the Naval Research Laboratory since 1946, has specialized in the design and operation of telemetering for rockets. For the past year he has served as head of the electronic instrumentation branch of Project Vanguard.

Col. A. H. DAVIDSON, JR., who directed all engineer planning operations in conjunction with the invasion of northern Europe in World War II, has been appointed director of the U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va. He succeeds Col. H. F. SYKES, JR., who retired from the Army on 31 July.

PAUL S. STOKELY, for 15 years a member of the teaching staff at Notre Dame University, will join the College of Steubenville (Ohio) as associate professor of biology.

CHARLES C. BOYER, formerly assistant professor of anatomy at the University of Alabama Medical Center, has been appointed associate professor of anatomy in the new West Virginia University Medical Center at Morgantown.

WALTER C. STANLEY, assistant professor of psychology at Brown University, has joined the staff of the Roscoe B. Jackson Memorial Laboratory at Bar Harbor, Me., to participate in studies on the development of behavior in dogs.

RICHARD E. SHOPE, member and professor of the Rockefeller Institute for Medical Research, received the Kober medal of the Association of American Physicians during its annual meeting in Atlantic City, N.J., last spring. He was honored for his work in the animal virus field.

ARTHUR V. JENSEN has been appointed assistant dean at New York Medical College, Flower and Fifth Avenue Hospitals. Jensen has been associate professor in the department of anatomy at the college for the past 4 years, a position he will continue to hold.

ARTHUR KORNBERG, head of the department of microbiology at Washington University Medical School, has been selected to head a new department of biochemistry at Stanford University School of Medicine. The appointment will become effective in July 1959, soon after completion of the Stanford Medical Center now under construction.

BENJAMIN B. BAUER, vice president in charge of engineering and research for Shure Brothers, Inc., Chicago, has been appointed head of the section for audio and acoustical research in the CBS Laboratories, a division of Columbia Broadcasting System, Inc.

BERTRAM S. KRAUS, associate professor of anthropology at the University of Arizona, has accepted a post as professor of physical anthropology in the department of orthodontics, School of Dentistry, University of Washington, Seattle. He will also be research associate in the department of anthropology.

Recent Deaths

MARY A. BENNETT, Macomb, Ill.; 68; professor emeritus of biological sciences and retired head of the department of biological sciences at Western Illinois University; 12 Aug.

JAMES D. CAMPBELL, Colton, Md.; 73; teacher of mathematics in D.C. schools for 42 years; 18 Aug.

J. A. DONDERO, Brooklyn, N.Y.; 56; research chemist specializing in dyes, solvents, and catalysts who became a fingerprint expert and president of Faurot, Inc., manufacturers of fingerprint equipment; 23 Aug.

DONALD MACKENZIE, Albuquerque, N.M.; 69; specialist in optics and acoustics, especially sound recordings; patents manager for Sandia Corporation, which operates the Sandia Special Weapons Base at Albuquerque for the Atomic Energy Commission; 20 Aug.

Sir CHARLES READ, Dartmouth, England; 54; outstanding gynecologist; honorary fellow of the American Gynecological Society; president of the Royal College of Obstetricians and Gynecologists; 21 Aug.

JOSEPH TYRRELL, Toronto, Canada; 98; geologist; former president of the Kirkland Lake Gold Mining Company; uncovered Canada's first fossil dinosaurs; 26 Aug.

CLAUDE C. VAN NUYS, Brea, Calif.; 79; former professor of physics and electrical engineering at both the South Dakota School of Mines and the Colorado School of Mines; retired chief physicist for the Air Reduction Company, Inc.; specialist in the theory of gaseous and liquid mixtures and their separation, the thermodynamics of solutions, and the chemistry of substances; 19 Aug.

MAX WEISSMAN, New Haven, Conn.; 62; senior psychiatrist at Kings County Hospital, New York; for many years assistant to Julius Wagner–Jauregg, Nobel prize winning director of the University of Vienna psychiatric clinic; 24 Aug.

Reports

Occurrence of l-Quinic Acid in Tobacco Leaves

Quinic acid has been isolated and identified as a constituent of various fruits and grasses (*1–3*). This report describes the isolation of *l*-quinic acid from mature green leaves of *Nicotiana tabacum* var. Connecticut shade-grown (*4*). Quinic acid is a normal constituent of the leaf, and preliminary data suggest that it may serve as a precursor of chlorogenic acid.

Separation of quinic acid from the major organic acid, malic acid, was achieved by displacement chromatography (*2, 3*). A water extract (*5*) of 30 g of dried green tobacco leaves was decolorized with 8 g of Darco G-60 (*6*) and passed successively through a column of Dowex 50-X8 (100 to 200 mesh, hydrogen form) (*7*) 15 cm by 3.5 cm^2 and a column of Dowex 1-X4 (200 to 400 mesh, acetate form) (*7*) 17 cm by 3.5 cm^2. The columns were washed with water, and the organic acids were displaced from the Dowex 1 with 0.1*N* HCl. Fractions of 10-ml volume were collected and examined by paper chromatography. Malic acid first appeared in fraction 20; fractions 4 to 17 contained a mixture of acids, including quinic and D-glyceric acids (*8*). These fractions were pooled, and the quinic acid was separated from the other acids by elution from the column of Dowex 1 with 1*N* acetic acid, as has been previously described (*8*). The quinic acid occurred in fractions 32 to 44, immediately preceding glyceric acid. It was isolated from these fractions essentially as described by Anet and Reynolds (*3*), except that the residue after the initial evaporation was dissolved in water and dried in a vacuum to remove the last traces of acetic acid, and the final crystallization from water was omitted.

The acid isolated from tobacco leaves exhibited the same chromatographic behavior on ion-exchange columns and on filter paper as authentic *l*-quinic acid. It is eluted just ahead of glyceric and glycolic acids from Dowex 1 columns in the acetate form (*5*) and has an R_F of 0.30 in an ether-formic acid-water solvent system (*5*) and an R_F of 0.48 in propanol-ammonia-water (60/30/10) (*9*).

The melting point (165° to 166°C), specific rotation ($[\alpha]_D^{20} = -42.5°$; concentration, 0.8 g/100 ml), and infrared spectra were identical with those of authentic *l*-quinic acid. A mixture showed no depression of the melting point. The isolated sample turned brown just before melting, presumably because of a slight contamination with impurities from the resin.

This specimen of quinic acid was isolated from tobacco leaf samples which had been dried at 80°C for 3 hours. Chlorogenic acid (a depside between quinic and caffeic acids) is present in tobacco leaves, and drying of the leaves results in extensive losses of this acid (*10, 11*). Thus, it was possible that all or part of the quinic acid present was a product of the decomposition of chlorogenic acid. As a test of this point, three identical samples of green leaves were extracted by different techniques, and the chlorogenic and quinic acid contents were compared. One sample was air-dried at 80°C and extracted with hot water, the second was plunged immediately after picking into boiling water, and the third was plunged into boiling 80 percent ethanol. The latter two techniques have been shown to prevent the loss of chlorogenic acid (*11*). The leaf material was held at the boiling point for several minutes, was cooled, and was homogenized in order to extract the acids.

The quinic acid in the extracts was determined by ion-exchange chromatography on Dowex 1 columns in the acetate form (*5*). The fractions containing the quinic acid were taken to dryness at 50°C while air was blown on the surface (*5*), water was added to the residue, and the mixture was again dried before titration with dilute alkali. Yields in excess of 100 percent are obtained if this second drying step is omitted. Chlorogenic acid was estimated by measurement of the optical density of the appropriately diluted solutions at 324 mμ (*12*).

All three samples contained approximately the same quantity of quinic acid, despite the fact that an 80-percent loss of chlorogenic acid occurred in the air-dried sample. In fact, the quinic acid content of oven-dried samples is usually less than that of comparable samples extracted directly by boiling solvents. Paper chromatography of the extracts (*11*) revealed a single, rather ill-defined spot whose R_F was identical with that of authentic chlorogenic acid. The relative intensities of the spots provided qualitative confirmation of the spectroscopic results.

These data provide proof of the occurrence of *l*-quinic acid in the green tobacco leaf. For reasons that are not known, the quantity present varies widely from sample to sample, ranging from a trace to as much as 3.5 percent of the dry weight. The chlorogenic acid content of tobacco also fluctuates over a wide range (*11*).

The metabolic role of quinic acid is not known. Oxidation yields citric and malonic acids, and one possible pathway for utilization could be by way of citric acid (*1*). Quinic acid could also serve as an intermediate in aromatic biosynthesis (*13*), or it could react with caffeic acid to form chlorogenic acid.

A few preliminary experiments have been carried out in an attempt to define this role. When leaf disks were floated on 0.2*M* quinic acid solutions at *p*H 3.5 or 5 for 24 hours in the dark, they took up the acid readily, and about 25 percent of the uptake was utilized during this period. There was no evidence of a direct conversion to citric acid, but there was an apparent increase in chlorogenic acid of 20 percent at *p*H 5 and of 37 percent at *p*H 3.5. However, these figures were obtained from the increase in optical density at 324 mμ, and recent work (*11*) has reemphasized the necessity for caution in interpreting such spectroscopic data. Further studies await the development of more reliable techniques for the assay of chlorogenic acid and related compounds.

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All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' names(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in Science 125, 16 (4 Jan. 1957).

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5 July 1957

Physiological Response to Air Exposure in Codfish

When diving mammals and birds submerge they exhibit a series of characteristic phenomena. The heart rate slows down. Lactic acid accumulates in the muscles, but only a very little leaks out into the circulation, because blood flow through the muscles is strongly depressed. This part of the picture is virtually the same whether the animal is quiet or active during the dive. In the recovery after the dive, circulation increases, and the lactic acid from the muscles pours into the blood. These and other adjustments are strikingly developed in many diving mammals and birds and have been found, in a more or less pronounced degree, in every warm-blooded animal where such investigations have been made. Man also frequently develops a pronounced bradycardia during diving, even while swimming vigorously (*1*).

Unpublished experiments performed at Woods Hole, Mass., several years ago indicated that similar mechanisms operate in dogfish (*Squalus*) when they are taken out of water, and these observations led to the present investigation (*2*) on codfish (*Gadus callarias*) at the Biological Station at Drøbak, Norway.

Heart rate and lactic acid in blood and muscles were determined (i) when the fish were resting quietly in the water, (ii) when they were taken out of water and left struggling in air for 4 minutes, and (iii) when they were placed back in water for recovery. Heart rates were taken on the same fish throughout the sequence, but lactic acid samples were, in all cases, taken from different fishes and give therefore a statistical picture of the sequence. Heart rates were obtained by means of an electrocardiograph. Blood or muscle samples for lactic acid determinations were taken immediately after removing the fish from the water and were analyzed colorimetrically (*3*).

When the fish was taken out of water the heart rate dropped within a few seconds to half or less of normal (Fig. 1), and this bradycardia persisted even through violent muscular activity. When the fish was put back in water the normal pulse rate was rapidly restored.

In the muscles the lactic acid rose to a maximum during the air exposure and fell as soon as the fish was put back into the water. In contrast, the blood lactic acid remained low during the air exposure but rose in the recovery period and reached a maximum after some 5 to 15 minutes. As recovery proceeded, the lactic acid in blood and muscles slowly dropped back to normal (Fig. 1).

These events, produced by taking the fish out of water, are strikingly similar to those found when mammals and birds are submerged, and they very probably indicate the same sort of protective mechanisms against asphyxia—namely, a circulatory bypass of the muscles, which are thereby left isolated to operate on their own anaerobic resources. The bradycardia is very probably a direct consequence of the restricted peripheral blood flow, for at least in some diving mammals, the main arterial blood pressure does not drop during the bradycardia, which suggests that normal blood flow may be maintained in organs less capable of anaerobic functions than the muscles. The similarity of this mechanism to those present in diving mammals goes even further, inasmuch as bradycardia in the fish can be induced, just as in a seal, simply by frightening the animal. This "diving reflex" might seem to be an excellent idea for a flying fish, but how it could ever benefit a codfish is an evolutionary puzzle.

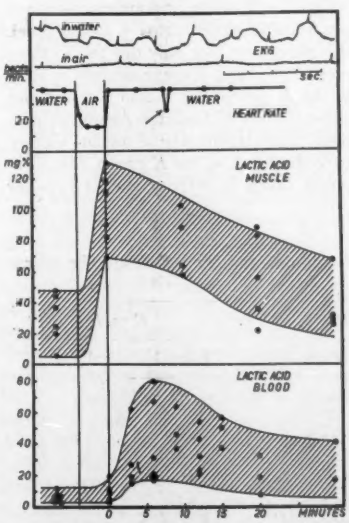

Fig. 1. Electrocardiograph tracings, heart rate, and content of lactic acid in muscles and blood of the codfish. The fish was taken out of water for 4 minutes. At arrow, hand was placed around submerged animal.

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24 June 1957

Irregular Maintenance Schedules and Drive

In animal experimentation the hunger drive is usually defined in terms of hours of food deprivation. Attention is rarely paid to the animal's prior history of deprivation. The deprivation history of an appetitive drive is controlled by means of a maintenance schedule—that is, the schedule of eating and deprivation intervals to which the animal is subjected over a period of time. If maintenance schedules affect subsequent behavior, then any variation from laboratory to laboratory may account for discrepant experimental findings.

Although it is known that irregular reinforcement profoundly affects animal behavior and is also a prominent feature of learning conditions outside the laboratory, almost nothing is known about the effects of irregular maintenance schedules. The present set of experiments represents a first attempt to study the effects of irregular food maintenance schedules on learning in the albino rat (*1*). It is expected that irregular schedules would elevate the drive effect of the deprivation interval used at time of testing.

In experiment 1, two groups of 70-day-old rats were placed on the following food maintenance schedules: a regular (R) group ($N = 5$) received 12 g of mash every 12 hours, and an irregular (I) group ($N = 6$) averaged the same amount of daily food intake but experi-

Table 1. Results of experiments 1 and 2. All p values refer to the significance of differences between group means based on t-tests; n.s. means not significant.

Item	Expt. 1					Expt. 2				
	R group ($N=5$)		I group ($N=6$)		p	R group ($N=10$)		I group ($N=10$)		p
	Mean	S.D.	Mean	S.D.		Mean	S.D.	Mean	S.D.	
Acquisition										
Trials										
Original task	20.0	9.4	13.5	4.1	n.s.	19.1	13.9	22.5	12.3	n.s.
Reversal task	16.0	6.5	21.7	9.3	0.006	13.5	7.1	17.0	9.2	0.07
Errors										
Original task	23.4	11.3	17.0	5.7	n.s.	28.5	26.8	33.1	18.1	n.s.
Reversal task	20.0	9.3	29.8	15.1	0.002	14.8	9.9	23.7	16.7	0.14
Disruption										
Vicarious trials and errors	4.9	4.1	1.2	1.2	0.03	7.4	6.8	2.7	3.3	0.04
Repeated errors	3.3	2.0	2.3	1.5	0.17	4.4	3.4	2.3	1.3	0.06
Latency	66.0	45.3	22.2	18.7	0.02	109.8	131.3	39.4	59.7	0.07

enced deprivation intervals varying from 12 to 48 hours. These schedules were maintained throughout the course of the experiment.

After 18 days the animals were introduced into a four-unit successive T-maze and trained to run a single alternation pattern (left-right-left-right). They were given five trials per night. Nights of running were spaced 48 hours apart, with a 72-hour interval every 6 days. This procedure gave the I group one 48-hour deprivation interval every 6 days, while at the same time enabling them to catch up with the R group on food intake and weight by the next night of running. All animals were run 12 hours deprived.

The R group received 12 g of mash 12 hours before running. The I group received from 12 to 18 g at this time. The exact amount was dependent on how much they had been deprived in the previous 48 hours, but it averaged 22 g. Care was taken to see that the weights of this group equaled or exceeded those of the R group at all times of running. In terms of food intake, the I group always received at least 12 g of mash more than the R group in the 24 hours preceding running. Therefore, on the basis of amount of food deprivation alone, at the time of measurement, the I group should be operating at a lower drive level than the R group.

When the animals reached a criterion of 95-percent correct choices on one night, the pattern was reversed to the mirror image, and they were required to learn this new pattern.

In experiment 2, all animals were given 50 overlearning trials before reversal. The R group ($N=10$) was maintained as in experiment 1, but the I group ($N=10$) had a slightly different schedule. Deprivation intervals ranged from 3 to 30 hours, and amount of mash per feeding varied from 4 to 22 g. By this procedure, not only did the I group receive the same average amount of food as the R group, but it also received the same number of feedings. Again, weights were comparable, the I mean slightly exceeding that of the R group. Measurements taken in activity wheels just before feeding showed no differences between the two groups (*2*).

It was expected that the I groups in both experiments would show behavior similar to that of animals tested under high-drive conditions. For purposes of such a comparison, previous data were available which compare 12-hour- and 36-hour-deprived animals (low- and high-drive groups) in two parallel experimental situations (*3*). Our R groups are equivalent to the previous 12-hour groups, while the I groups should show behavior more similar to that of the previous 36-hour groups.

Three dependent variables were utilized in the two studies: acquisition of original learning and of reversal learning and amount of response disruption occurring during the first trial of reversal. Table 1 summarizes the results of the present experiments. Table 2 compares differences between the R and the I groups with the differences obtained with the 12-hour and 36-hour groups. It can be seen from Table 1 that in the acquisition of the original task, the differences are not significant and are in opposite directions for the two experiments. During reversal learning, with analysis of covariance used as the control for original learning, the R groups showed faster acquisition than did the I groups in both experiments. Response disruption on the first trial of reversal was analyzed by means of three measures: number of vicarious trials and errors, number of repeated errors, and latency of the first correct response. The R groups made higher scores (showed more disruption) on all three measures than did the I groups, although only the vicarious trial and error and latency measures reach statistical significance.

From Table 2 it can be seen that the present results show some correspondence with the high- versus low-drive (*HD* and *LD*) experiments on errors during reversal learning and consistent correspondence on the various measures of response disruption. There was a lack of any agreement on acquisition of the original task. Thirty-six-hour-deprived animals consistently learned the original task slightly faster than did the 12-hour animals, whereas this was not the case with the I and R groups. One additional difference was noted. The 36-hour groups showed faster mean running speeds than did the 12-hour groups, whereas in the present study no consistent differences were found. In general, whenever significant differences were found between high-drive and low-drive animals, they were paralleled by corresponding differences between irregular and regular animals. Thus, irregularly deprived animals show more characteristics of animals in a high-drive state than do regularly deprived animals.

Table 2. Comparison of the effects of drive levels and maintenance schedules. The abbreviation n.s. means not significant.

Item	*LD* vs. *HD**		R vs. I	
	Expt. 1	Expt. 2	Expt. 1	Expt. 2
Acquisition				
Trials				
Original task	n.s.	n.s.	n.s.	n.s.
Reversal task	n.s.	n.s.	$R < I$	$R < I$
Errors				
Original task	n.s.	n.s.	n.s.	n.s.
Reversal task	n.s.	$LD < HD$	$R < I$	n.s.
Disruption				
Vicarious trials and errors	$LD > HD$	$LD > HD$	$R > I$	$R > I$
Repeated errors	n.s.	$LD > HD$	n.s.	$R > I$
Latency	$LD > HD$	$LD > HD$	$R > I$	$R > I$

* Data from *3*. All comparisons from this study are significant at the 0.05 level or better.

It is suggested that when drive level is defined in terms of hours of deprivation, the animals' prior history of maintenance schedules must be taken into account. Experiments on the effects of deprivation experiences occurring in infancy are now in progress.

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1 July 1957

Release of 5-Hydroxytryptamine by Benzoquinolizine Derivatives with Sedative Action

Previous investigations have shown that reserpine causes release of 5-hydroxytryptamine (5-HT) from various body depots (brain, intestine, and blood platelets). After a single injection of a large dose of reserpine, the 5-HT content of these organs decreased to values between one-fifth and one-tenth of the normal levels and remained low for several days. Among the *Rauwolfia* alkaloids, only those with tranquilizing action showed this effect. A series of centrally acting drugs belonging to other chemical groups did not influence the 5-HT content of the brain (*1*).

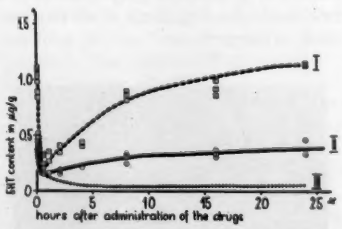
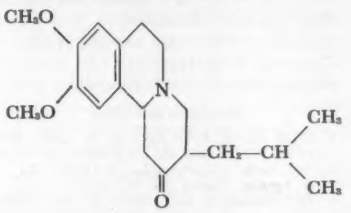


Fig. 1. Effect of compound I and reserpine on the 5-hydroxytryptamine (5-HT) content of brain. The drugs were given at zero time. Broken curve, intraperitoneal injection of 40 mg/kg of compound I to mice; each point represents the 5-HT concentration of five pooled brains. Solid curve, intravenous injection of 40 mg/kg of compound I to rabbits; each point represents the 5-HT concentration of one whole brain. Dotted curve, intravenous injection of 5 mg/kg of reserpine to rabbits (*3*).

It has now been found that, besides reserpine, various synthetic derivatives of 1,2,3,4,6,7-hexahydrobenzo[a]quinolizines (*2*) also release 5-HT. In mice and rabbits, these compounds produce sedation without hypnosis. Among the derivatives examined, compound I (2-oxo-3-isobutyl-9,10-dimethoxy-1,2,3,4,6,7-hexahydro-11bH-benzo[a]quinolizine)



I

showed the most marked sedative and 5-HT-releasing activity (Fig. 1).

After injection of 40 mg of compound I per kilogram, there was an immediate decrease of the brain 5-HT, measured fluorimetrically (*3*), the minimum value being reached within half an hour. As the dose was reduced, the 5-HT decline became gradually smaller, but was still evident with as little as 5 mg of compound I per kilogram. The absolute decrease in 5-HT per gram of tissue was greater in the brain stem than it was in the rest of the brain. During a 4-hour period after injection of 40 mg/kg in rabbits, the colorimetrically determined excretion of 5-hydroxyindoleacetic acid (*4*), a major metabolite of 5-HT, showed an average significant increase of 200 percent as compared with a similar control period before injection ($p < 0.01$). In rabbits, pretreatment with isopropyl isonicotinic acid hydrazide had the same influence on the effect of compound I as on that of reserpine (*5*): compound I no longer caused sedation, but excitation, mydriasis, and piloerection; the brain 5-HT showed only a very slight decline.

In addition to these similarities between the action of compound I and reserpine on the brain 5-HT, there were, however, some differences. (i) To reach maximum depression of 5-HT in the brain, mice required 4 times and rabbits 10 times as much compound I as was required of reserpine. In mice, the LD_{50} of compound I was about 10 times higher than the LD_{50} of reserpine. (ii) After administration of reserpine, the 5-HT in the brain decreased to a minimum of 10 percent, whereas after administration of compound I, the 5-HT concentration was never less than 25 to 35 percent of the original value. Even with doses exceeding 40 mg of compound I per kilogram, no greater decrease of 5-HT could be produced. (iii) Within 10 to 24 hours after injection of compound I, the 5-HT content of the brain had returned to normal values, whereas, after administration of reserpine, complete 5-HT recovery took several days. The sedative action of compound I lasted 4 to 8 hours, that of reserpine 1 to 3 days.

The benzo-quinolizine derivatives are thus a second group of substances which, like the centrally acting *Rauwolfia* alkaloids, cause both sedation and 5-HT depression in the brain. Closer investigations with these compounds may lead to further explanation of the role of 5-HT in brain function and in the central action of certain drugs.

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13 May 1957

Nature of the Glucuronide in Direct-Reacting Bilirubin

Evidence from several laboratories (*1–3*) has established that direct-reacting bilirubin is a diglucuronide. Billing, Cole, and Lathe (*1*) have suggested that bilirubin may be conjugated with glucuronic acid through its carboxyl groups, since the glucuronide is readily hydrolyzed by dilute alkali. Schmid (*3*) has assumed that the glucuronidic linkages occur with the α,α′-hydroxy groups of bilirubin.

Carboxyl (acyl) glucuronides can be differentiated from other glucuronides by the capacity of the former to react with hydroxylamine to yield hydroxamic acids and glucuronic acid (*4*). Treatment of bilirubin diglucuronide with hydroxylamine, therefore, provides a means of determining the nature of the glucuronidic bonds (*5*).

Urines obtained from three patients with obstructive jaundice were the source of the direct-reacting bilirubin (*3*). In each instance, treatment of an aliquot of the urine with hydroxylamine (*p*H 7, room temperature, 30 minutes) resulted in the formation of an appreciable quantity of hydroxamate. When the urine

samples were treated with 0.2*N* NaOH for 10 minutes at room temperature, the direct-reacting bilirubin was converted to indirect-reacting bilirubin, and the capacity to form hydroxamate was lost. The data presented in Table 1 show a fairly constant proportionality between the decrease in hydroxamate formation and the amount of direct-reacting bilirubin converted to the indirect-reacting form.

The direct-reacting bilirubin in urine was converted to the stable azopigment B (*3*) by coupling with diazotized sulfanilic acid. The product was extracted with *n*-butanol, purified by ascending chromatography on washed Whatman No. 3 paper, with water-saturated *n*-butanol, acetic acid (4/1) as the solvent, and eluted with absolute methanol. Azopigment B can be converted to azopigment A, with the liberation of glucuronic acid, either by dilute alkali (0.2*N* NaOH, 10 minutes, room temperature), by acid (1*N* H_2SO_4, 80 minutes, 100°C), or by the action of bacterial β-glucuronidase (Sigma, 20 mg/ml, *p*H 6, 38°C, 18 hours) (*1, 3*). With ascending chromatography on Whatman No. 1 paper and with water-saturated *n*-butanol, acetic acid (4/1) as the solvent, azo-pigments B and A migrate with R_f values of 0.36 and 0.55, respectively.

Treatment of azopigment B with an excess of hydroxylamine (*p*H 7, room temperature, 30 minutes) yields a new pigment, which migrates as a single spot with an R_f value of 0.44. This product, assumed to be the hydroxamate of azopigment A, has an absorption spectrum at *p*H 6.0 identical with that of azopigment B between 330 and 600 mμ, with maximal absorption at 525 mμ. In contrast to azopigment B, the hydroxamate is free of hexuronic acid, estimated by the carbazole method (*6*), and is unchanged by dilute alkali or bacterial β-glucuronidase, as judged by paper chromatography. However, on treatment with 1*N* H_2SO_4 for 80 minutes at 100°C, the hydroxamate is converted to a pigment with an R_f value identical to that of azopigment A.

These observations indicate that bilirubin diglucuronide, and the azopigment B derived from it, react with hydroxylamine to form the corresponding hydroxamic acids. This reaction, specific for *acyl* glucuronides, provides direct confirmation that bilirubin is conjugated with glucuronic acid through its carboxyl groups.

Table 1. Effects of mild alkaline hydrolysis on the van den Bergh reaction and on hydroxamate formation in the urine of patients with obstructive jaundice. The van den Bergh reaction was performed according to the method of Malloy and Evelyn (*7*), and hydroxamate was estimated as has been previously described (*4*); both are expressed in units of optical density.

Patient	Δ van den Bergh		Δ Hydroxamate
	Direct	Indirect	
D	−190	+150	−084
S	−616	+464	−226
N	−920	+696	−367

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17 June 1957

Absence of Chitin in Epicuticle of Some Indian Scorpions

Epicuticle of arthropods is defined by Richards (*1*) as a characteristically nonchitinous layer. Krishnan, Ramachandran, and Santanam (*2*), on the other hand, demonstrated the presence of chitin in the epicuticle of a scorpion *Palamneus swammerdami* (*3*). It was therefore decided to test the epicuticle of other scorpions for chitin.

The scorpions *Palamnaeus bengalensis* and *Buthus tamulus gangeticus*, commonly found at Lucknow, were used for the study. When pieces of cleaned cuticle of freshly killed scorpions were subjected to the chitosan test, the epicuticle gave a negative reaction for chitin. Some pieces of cuticle which had been previously treated with alkali during the chitosan test were placed in 3 percent acetic acid overnight, but the epicuticle did not show dissolution. This would suggest further that the epicuticle is nonchitinous.

Krishnan *et al.* (*2*) had suggested that the epicuticle of *P. swammerdami*, unless previously treated with chlorated nitric acid, would not respond to the chitosan test. Even repetition of Krishnan's method in the cuticle of *P. bengalensis* and *B. tamulus gangeticus* did not give, with 1 percent sulfuric acid, any violet coloration characteristic of chitosan in the epicuticle. This would indicate that chitin is absent from the epicuticle of the scorpions *P. bengalensis* and *B. tamulus gangeticus*.

X-ray diffraction studies were also carried out in order to detect the presence, if any, of chitin in the epicuticle of these scorpions. Pieces of cuticle of the two scorpions under experiment were treated with several changes of cold, freshly prepared concentrated chlorated nitric acid till the epicuticle was completely freed of the underlying exocuticular material. Pieces of epicuticle thus obtained were thoroughly washed in running water and then in distilled water. For the x-ray diffraction experiment, 12 pieces were mounted, one over the other, on a small hole on a glass slide and left in a desiccator overnight. The pieces of epicuticle stuck together and to the slide during the drying process; after this the x-ray diffraction photographs were taken. Cu-K-alpha radiations were used, and the object was kept perpendicular to the beam and at a distance of 5 cm from the photographic plate.

Figures 1 and 2 show the diffraction patterns of the epicuticle of *P. bengalensis* and *B. tamulus gangeticus*, respectively. Prominent d-spacings in the epicuticle of *P. bengalensis* and *B. tamulus gangeticus* occur at 5.302 A and 3.901 A (faint) and at 3.007 A, 3.941 A, and 5.219 A, respectively.

Krishnan *et al.* (*2*) have suggested the presence of chitin in the epicuticle of *P. swammerdami* on a comparison of the d-spacings 3.37 A, 4.1 A, and 9.1 A obtained in the epicuticle after removal of the outer paraffin layer present in their scorpion, and of the d-spacings 2.22 A, 2.44 A, 3.7 A, and 4.14 A obtained in the entire epicuticle, with the d-spacings 3.3 A, 4.55 A, 5.0 A, and 9.9 A obtained in the purified chitin of *P. swammerdami*. The d-spacings obtained in the epicuticle of the scorpions *P. bengalensis* and *B. tamulus gangeticus* are different from all the d-spacings obtained by Krishnan in *P. swammerdami*. Furthermore, the d-spacings of the epicuticle of *P. bengalensis* and *B. tamulus gangeticus* do not tally with the d-spacings of chitin from other arthropods.

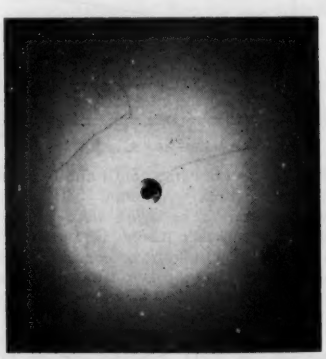

Fig. 1. X-ray diffraction photograph of the epicuticle of *P. bengalensis*.

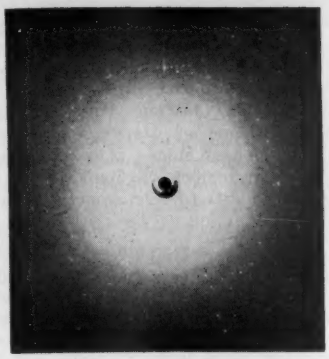

Fig. 2. X-ray diffraction photograph of the epicuticle of *B. tamulus gangeticus*.

It is evident that the epicuticle of the scorpions *P. bengalensis* and *B. tamulus gangeticus* is nonchitinous.

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17 June 1957

Withdrawal of Positive Reinforcement as Punishment

Many experiments have shown that an organism's behavior can be maintained by the use of positive reinforcement (reward). At the same time, the withdrawal of the situation in which the reinforcement occurs has been described as an aversive event (*1*) and is called a "time out." This experiment (*2*) shows some of the aversive properties of a time out from positive reinforcement in chimpanzees. The procedure here is very similar to one used by Azrin in which electric shock is the aversive event and pigeons are the subjects (*3*). In such cases, light or sound (pre-aversive stimulus) preceding the aversive event disrupts the animals' usual performance.

In this experiment the aversive event (time out from positive reinforcement) was established as follows. The chimpanzees pressed a telephone key, which occasionally produced food. An overhead light in the experimental chamber was periodically turned off, and at the same time the food magazine was disconnected from the key. The animals soon stopped pressing the key in the absence of the overhead light. Thereafter, the experiment could be interrupted conveniently for any period of time by turning off the overhead light.

A red lamp, called the pre-time-out or pre-aversive stimulus, was then installed next to the key. The light appeared every 15 minutes for 160 to 180 seconds, depending on the animals' performance. If an animal pressed the key during the last 20 seconds of the pre-time-out period, a 60-minute time out followed; but if it did not press the key during the final 20 seconds, the red light terminated, and no time out could occur until 15 minutes later, when the pre-time-out stimulus reappeared.

Key presses were reinforced on a variable-interval schedule in which the first key press after varying periods of time was reinforced. The mean interval between reinforcements was 6 minutes, with a range between zero (successive responses) and 12 minutes.

Figure 1 contains an entire daily record, 6 hours long, representing the stable performance after several hundreds of hours of exposure to the experimental procedure. Responses are cumulated against time, and the diagonal strokes on the curve indicate the start and end of the pre-time-out stimulus. The performance was recorded continuously; however, to facilitate inspection of the performance during the pre-time-out stimulus, the curve was broken into 15-minute segments with the pre-time-out period in the middle. The grid in the lower right part of the figure gives the coordinates, the scale of the record, and several reference slopes in responses per second. The reinforcements are not shown on the curve.

The resulting performance with the time out as the aversive event closely parallels the data reported by Azrin. The aversive properties of the time out appeared as suppression of the key-pressing during the pre-time-out stimulus. The degree of suppression ranged from the performance in the fourth segment of the second column, where suppression is complete, to the performance in the preceding segment, where the chimpanzee stops pressing the key only during the last 35 seconds. In most cases the chimpanzees pressed the key during the early part of the pre-time-out stimulus at the rate of responding that generally prevailed elsewhere, but they stopped abruptly some time before the final 20 seconds, when a response would produce a time out. Time outs occurred in approximately 3 percent of the pre-time-out stimuli. In the session represented in Fig. 1 a time out occurred at the arrow.

The suppression of the base-line behavior by the stimulus preceding the time out from the variable-interval schedule of reinforcement establishes the time out as an aversive event having properties similar to those of electric shock. The time out as an aversive event can be extrapolated to most aversive control in human behavior, where noxious stimuli such as corporal punishment or electric shock are rarely used. On the other hand, positive reinforcement is frequently discontinued, as in fines, disapproval, or incarceration. The important feature in such types of control is that an individual is punished by the withdrawal of the reinforcements for significant segments of his behavioral repertoire. Such withdrawal is similar to the time out of the present experiment.

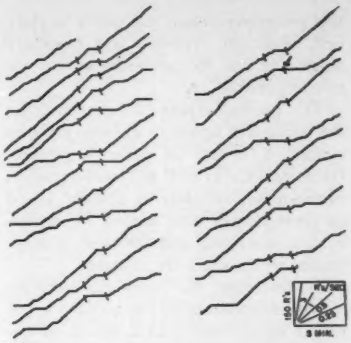

Fig. 1. Complete daily session showing suppression of key-pressing during the pre-time-out stimulus.

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* Now at the Institute of Psychiatric Research, Indiana University Medical Center, Indianapolis.

11 July 1957

Gamma Globulin Factors Protective against Infections from Pseudomonas and Other Organisms

In mice rendered susceptible to *Pseudomonas aeruginosa* infections by pretreatment with cortisone or by extensive thermal trauma, human gamma globulin (GG) administered after the infection was shown to be highly active in preventing death (*1*). The nature of

this protective action has not been clarified, although evidence was presented suggesting that the properdin system was not responsible (*1*).

The present report (*2*) demonstrates the protective action of gamma globulin against a variety of other organisms, Gram-positive as well as Gram-negative; furthermore, an assay of plasma, based on protection of mice against *Ps. aeruginosa,* is described, and the titers in some laboratory animals are reported.

In this study, the organisms were injected intraperitoneally, suspended in 0.4 to 0.5 ml of mucin, as a means of enhancing the infection (*3*). Mucin obviated the use of cortisone and produced infections that were more rapidly fatal (12 to 36 hours). Results with this procedure were found to be more reproducible, particularly in the assay of titer of plasma preparations by mouse protection tests, described in the following paragraph. From one to ten lethal doses of organisms were used, and the gamma globulin or plasma was administered intraperitoneally, 3 to 4 hours prior to the infection, unless otherwise stated. Preparation of the organisms was similar to that previously described (*1*).

Table 1. Protective action of human gamma globulin against various infections in mice. Centrifuged organisms suspended in 0.9 percent NaCl to optical density of 0.45 to 0.50 at 650 mμ, before dilution in 5 percent gastric mucin (hog); 0.4 to 0.5 ml of suspension inoculated intraperitoneally; 0.1 ml (16 mg) of gamma globulin given intraperitoneally 3 to 4 hours before inoculation.

Organism, type or strain	Organism diln. in mucin	No. of mice in each group	72-hr mortality (%)	
			Untreated	GG-treated
Ps. aeruginosa				
Strain 180	10^{-3}	30	90	13
	5×10^{-3}	20	95	20†
	5×10^{-3}	10	95	40‡
Strain 181	10^{-3}	10	90	40
Parker	10^{-3}	10	90	10
G-140	10^{-2}	10	90	40
E. coli				
Rowley				
0111:B4:H12	10^{-6}	20	95	100
	10^{-6}	10	100	90
Stokes 0111:B4	10^{-3}	20	60	60
08:K42(A)	10^{-2}	10	90	90
	10^{-3}	20	95	65
09:K29(A)	10^{-2}	10	100	70
6641(L)	2×10^{-1}	10	80	30
ATCC 9637	10^{-1}	10	80	0
02:K1(L)	10^{-5}	10	100	100
010 K5(L)	10^{-3}	10	100	100
	10^{-4}	10	80	90
	10^{-5}	10	90	70
Proteus				
mirabilis	10^{-5}	10	100	10
mirabilis, Kf20	10^{-3}	10	100	0
vulgaris, Kf56	10^{-3}	10	40	60
morgani, C90	10^{-1}	10	70	50
rettgeri, 1165	10^{-1}	10	80	50
Klebsiella				
Kl. pneumoniae				
K-2	10^{-2}	10	80	100
Bact. aerogenes				
K-10	10^{-2}	10	70	0
Bact. aerogenes				
1033	10^{-1}	10	70	0
Bact. aerogenes				
8329 (ATCC)	10^{-4}	10	90	20
*St. aureus**				
Wood, ATCC				
10832	10^{-1}	20	100	20
Georgio	10^{-1}	10	100	30
713 A	10^{-1}	10	100	20
Smith	10^{-5}	20	100	5
	10^{-5}	10	90	0†

* Cultures diluted in mucin without centrifugation.
† Gamma globulin given intravenously immediately after inoculation.
‡ Gamma Globulin given intramuscularly 5 hours before inoculation.

Protection with human gamma globulin was demonstrated against several strains of *Ps. aeruginosa, Escherichia coli, Proteus, Klebsiella,* and *Staphylococcus aureus* (Table 1). Marked protection was found against four strains of *Micrococcus pyogenes* var. *aureus,* with gamma globulin given intraperitoneally 24 or 4 hours before the infection or intravenously shortly after the infection. Similar protection was shown against *Ps. aeruginosa,* except that less effect was present with gamma globulin administered intraveneously, post infection; however, good protection was obtained under these conditions with a smaller inoculum. Activity against *E. coli* was weak, with the exception of two strains of low mouse virulence. Protection was shown against three strains *of Bacterium aerogenes* but not against one strain of *Klebsiella pneumoniae.* Further work is required to determine the relation of protective titer to pathogenicity or antigenic types of bacteria. Since human gamma globulin prepared for the American Red Cross represents samples pooled from 20,000 individuals, the activity may be taken as representing the mean of large sectors of the population.

The assay of protective titer of the plasma of laboratory animals was similar to the experiments just described; protective action of citrated plasma was tested in mice inoculated intraperitoneally with *Ps. aeruginosa,* strain 180, in mucin. To increase the sensitivity of the assay system, advantage was taken of the synergistic effect obtained when certain antibiotics are combined with gamma globulin or plasma (*4*). Thus, a single dose of oxytetracycline (8 to 10 mg/kg) given subcutaneously, immediately after the infection, was essentially without effect when given alone, but it enhanced the activity of gamma globulin or plasma several-fold. The use of antibiotics was advantageous with plasma of low titer, such as in the mouse, and it was employed routinely in all cases, so that comparative data for the various animals could be obtained.

The results (Table 2) indicate an order of potency of plasma from adult animals as follows: human being, dog, rat, rabbit, guinea pig, and mouse. These values must be accepted as only tentative, since the titer may be influenced by the strain, age, and past history of the animal; preliminary experiments indicate weaker titers in young animals. With the use of oxytetracycline, the potentiation of human plasma appears greater than that of human gamma globulin, although simultaneous com-

Table 2. Protective action of plasma of various laboratory animals against *Pseudomonas* infection in mice when combined with antibiotic therapy. Gamma globulin or plasma given intraperitoneally 3 to 4 hours before inoculation; oxytetracycline, subcutaneously, immediately after inoculation. Human plasma was a lyophilized preparation of commercial manufacture. *Ps. aeruginosa,* 10^{-3} dilution of organisms in mucin; 0.4 ml intraperitoneally. Since all plasmas were collected in citrate solution, a 30-percent dilution factor should be applied, except for the lyophilized human plasma.

Therapy	No. of mice	72-hr mortality (%)
No treatment	80	96
Oxytetracycline (8 to 10 mg/kg)	80	93
Human GG alone, 8 mg	29	33
Human GG + oxytetracycline		
0.5 mg	50	54
1.5 mg	50	42
5.0 mg	20	10
Human plasma alone, 0.1 ml	10	70
Human plasma + oxytetracycline		
0.01 ml	20	35
0.03 ml	30	13
0.10 ml	20	0
Dog plasma + oxytetracycline		
0.03 ml	10	80
0.10 ml	20	20
0.30 ml	10	10
Rat plasma + oxytetracycline		
0.1 ml	20	60
0.3 ml	20	35
1.0 ml	10	20
Rabbit plasma + oxytetracycline		
0.1 ml	10	80
0.3 ml	10	60
Guineapig plasma + oxytetracycline		
0.3 ml	30	73
1.0 ml	30	53
Mouse serum + oxytetracycline		
0.3 ml	10	80*
1.0 ml	10	80*

* Serum-treated mice in these experiments died at a slower rate than did untreated mice, indicating the presence of a small amount of protective activity in mouse serum.

parisons of gamma globulin prepared from the same plasma are needed to establish this.

Gaines and Landy (*5*), employing a hemagglutinin technique, demonstrated antibodies in normal human serums against a *Pseudomonas* antigen; higher titers were present in older age groups. Various investigators have demonstrated small amounts of *Staphylococcus* antitoxin in the serums of man and animals, and the antibacterial properties of normal serum have been widely investigated for many years (*3*). The role of these *in vitro* properties of serum in its protective action against lethal infections in animals remains to be established. However, Cameron (*6*) has demonstrated protective action from gamma globulin derived from several domestic animals against experimental infections with *Pasteurella multocida, Salmonella choleraesuis* and *Brucella suis*.

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2. We wish to acknowledge the cooperation of the American Red Cross for supplying the gamma globulin used in this study and of E. Verder and M. Landy of the National Institutes of Health, A. K. Miller of the Merck Institute, and E. Grunberg of Hoffman-La Roche, Inc., for cultures of organisms.
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22 April 1957

Interrelationship between Certain Bacteria and the Rumen Ciliate Dasytricha ruminantium

The cattle and sheep ciliates of the genera *Isotricha* and *Dasytricha* have been shown to possess considerable fermentation ability (*1, 2*). Soluble carbohydrates are rapidly utilized by the protozoans, with the production of acids and gas and with concomitant deposition of food reserve amylopectin. The nature of the nitrogen source for the holotrich ciliates has been elusive (*3*). The holotrich protozoans do not easily lend themselves to microscopic observation of bacterial feeding. In well-fed ciliates the entire organism is loaded with reserve food granules, making it difficult to detect either the presence of bacteria within the ciliates or bacteria actually being ingested by the protozoans.

Growth experiments with the holotrich protozoan *Isotricha intestinalis* have been reported (*2*). The ciliates grew during a short period in an anaerobic medium containing ground alfalfa, wheat, and untreated rumen fluid in inorganic saline. Counts of the protozoans during this time indicated division every 48 hours. The smaller, more abundant holotrich found in the rumen, *Dasytricha ruminantium*, did not survive in these experiments, indicating a difference in cultural requirements. It was of interest to find what these differences were and also what factors would stimulate growth of *D. ruminantium* in laboratory cultures.

Starvation of *D. ruminantium* for 48 to 72 hours decreased the number of amylopectin reserve granules and facilitated the search for bacterial ingestion by the protozoans. The starved ciliates were placed on a slide with a small amount of 0.5 percent saline and a mixture of bacteria obtained from fresh rumen fluid by centrifugation. A cover glass, ringed with Vaseline, excluded air from the entire suspension. With this arrangement the protozoans remained active and could be observed for several hours, with the use of a phase microscope. *Dasytricha ruminantium* selected and ingested small cocci, 0.5 to 0.8 μ in diameter, from the mixture. The bacteria agglutinated at the mouth located at the posterior of the organism and were gradually ingested. Occasionally, a ciliate was observed which swam about trailing many agglutinated bacteria. Small rod-shaped bacteria, 1.0×1.5 μ in size, were seen also within food vacuoles in the ciliates. In several of the experiments, exposure of the bacterial suspension to triphenyltetrazolium chloride allowed more distinct observation of bacterial ingestion by the protozoans. Bacteria which stained red as a result of the deposition of the insoluble formazan were seen localized near the mouth and in the interior of the ciliate in food vacuoles.

Several bacterial strains were isolated from rumen contents in order to test their growth-promoting effect on *Dasytricha*. Following the initial isolation on a starch-alfalfa extract agar, the bacteria were grown in liquid medium of the same type and used in the ciliate cultures. Small vessels with a flat upper surface and an opening fitted with a rubber stopper allowed observation of the protozoans without exposure to air. With the aid of a dissecting microscope, the response and fate of the ciliates in each experiment could be followed easily. With cooling of the cultures from 39°C to room temperature, most of the protozoans decreased their swimming activity and settled to the bottom of the vessel. The stale supernate was then removed with a capillary pipette, while anaerobic conditions were preserved by passing carbon dioxide into the vessel opening. Fresh 0.5 percent buffered saline containing substrate and bacteria was added every 24 hours. Streptomycin and penicillin, plus washing techniques, were used to free *Dasytricha* of most of the associated rumen bacteria.

Dasytricha ruminantium was cultured for 2 weeks in the presence of two species of rumen bacteria and the following components, given in percentage: 0.05 ground alfalfa, 0.005 cornstarch, 0.5 autoclaved rumen fluid, 0.005 glucose, and a mixture of ten vitamins. Cysteine hydrochloride, 0.01 percent, was added to insure reduced conditions. Numerous dividing ciliates were observed each day. Parallel control cultures which omitted the bacteria were dead at 96 hours. The bacterial strains which stimulated growth of *Dasytricha* were a small coccus, 0.8 μ in diameter, having a large mucoid colony, and a rod 1.0×1.5 μ in size, possessing a filamentous type colony. The larger holotrich ciliates of the genus *Isotricha* were also observed feeding on rod-shaped bacteria (*4*). It is concluded that the holotrich rumen ciliates derive at least some of their nitrogenous requirements from the ingestion of associated bacteria.

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8 July 1957

Rapid Chemical Changes in Reconstituted Dry Milk

Dry milk is usually reconstituted into an aqueous system before use as a food, and many of the laboratory analyses of dry milk involve reconstitution with water as a step in sample preparation. Recent study of certain chemical properties of reconstituted nonfat dry milk indicated a variability in analytic results which was correlated with the age of the reconstituted samples. The purpose of this report is to illustrate some rapid chemical changes which may occur in freshly reconstituted dry milk in order to bring the phenomenon of change to the attention of those interested in the

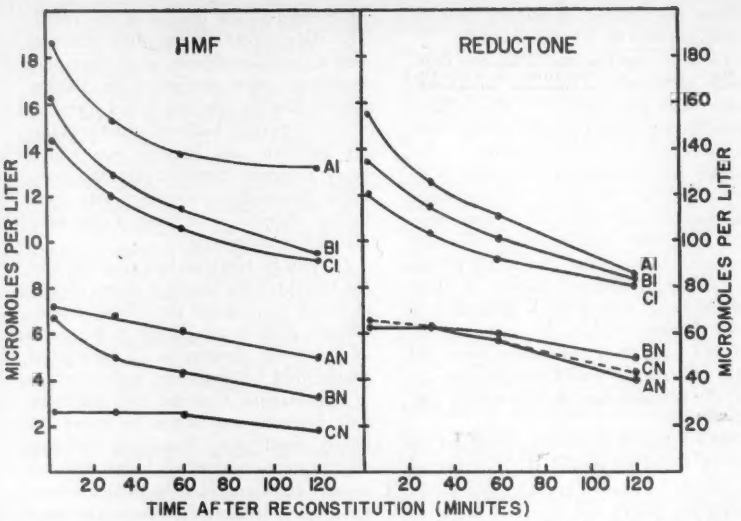

Fig. 1. Changes in certain chemical properties of reconstituted nonfat dry milk as functions of age. The letters *A*, *B*, and *C* designate different batches of dry milk from the same manufacturer; *I* and *N* designate the milks as instant (*6*) or noninstant products. The instant milks were prepared from the corresponding noninstant milks (for example, *AI* was prepared by instantizing *AN*, and so forth).

evaluation of either dry milk or dehydrated foods in general (*1*).

Figure 1 illustrates this effect as applied to two different chemical analyses on six samples of reconstituted nonfat dry milk. The samples were analyzed for 5-hydroxymethylfurfural (HMF) (*2*) and for indophenol-reducing substances (*3*). The 5-hydroxymethylfurfural analyses did not measure free 5-hydroxymethylfurfural in the milks but rather the amount formed under standardized digestion conditions. The quantity of 5-hydroxymethylfurfural formed under these conditions is believed to be correlated with the intensity of Maillard-type browning (*4*) reaction in the samples. The results of the indophenol titrations are expressed as molar concentration of diolreductone rather than as the conventional weight equivalent of ascorbic acid (*5*). The samples were prepared rapidly by shaking 10 g of milk powder with 100 ml of distilled water in a 250-ml erlenmeyer flask. Aliquot portions of the reconstituted samples (stored at 24°C) were removed at specified times for chemical analyses, the first samples being removed 3 minutes after the start of reconstitution.

The results shown in Fig. 1 definitely indicate that some rapid chemical changes were taking place in the freshly reconstituted instant (*6*) milks. The changes in the noninstant milks appeared to be less pronounced and more variable. Furfurals and reductones are well-known products of the browning reaction in foods containing sugar and protein (*4*). The higher levels of 5-hydroxymethylfurfural and reductones in the instant milks, as compared with their noninstant counterparts, indicate that the instantizing process used on these milks caused browning-type reactions to take place. Kumetat *et al.* (*7*) found that the ferricyanide-reducing values were generally higher in instant, as compared with noninstant, nonfat dry milks and concluded that instantizing promotes the browning reaction.

It would appear that certain characteristic products of the browning reaction accumulate in dehydrated foods and may be rapidly converted to other characteristic products upon hydration. A study of the chemistry of the browning reaction in model systems led Hodge (*4*) to the conclusion that the sugar in sugar-amine browning reactions can be dehydrated in two ways. (i) In neutral or acidic aqueous systems, furfurals are formed; (ii) in the dry state, reductones are formed. The Hodge conclusion may be an oversimplification of the situation; however, it does provide a well-defined example of the influence of water on the course of the browning reaction. Milk may be considered to be a representative sugar-protein food; therefore, the foregoing manifestations may be encountered in many other dehydrated foods.

In light of the growing market for dehydrated foods and the anticipated increase of interest in the study of manifestations of Maillard-type browning in such foods, it is suggested that the dynamic chemical state of freshly reconstituted products be carefully considered in the development of investigational procedures.

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References and Notes

1. Scientific article No. A626, contribution No. 2808, of the Maryland Agricultural Experiment Station, Dairy Department. Research was undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces and assigned No. 768 in the series of papers approved for publication. The views or conclusions contained in the report are those of the authors and are not to be construed as reflecting the views or endorsements of the Department of Defense.
2. A detailed report on this method of analysis is in preparation. Brief details are as follows. (i) Mix 10 ml of milk with 10 ml of 40 percent trichloracetic acid and incubate the mixture at 70°C for 25 minutes; (ii) cool and filter through Whatman No. 42 paper; (iii) add 1 ml of 0.05*M* 2-thiobarbituric acid to 4 ml of filtrate and incubate the mixture at 40°C for 50 minutes; (iv) determine absorbance at 443 mμ against blank substituting water for milk; (v) calculate 5-hydroxymethylfurfural from absorbance by reference to standard curve. The formula used on the milks was as follows: (absorbance $-0.062) \times 76 =$ micromoles per liter of 5-hydroxymethylfurfural in milk.
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5. A portion of the reducing activity may have been due to ascorbic acid, but it is inconceivable that the increased titer of the instant milks was attributable to the vitamin. The reducing substances were tentatively classified as reductones after study of the milks was made with the Lugg-Mapson formaldehyde condensation procedures [J. W. H. Lugg, *Australian J. Expl. Biol.* 20, 273 (1942); L. W. Mapson, *J. Soc. Chem. Ind.* 62, 223 (1943)].
6. The recently developed instant dry milks are manufactured by the wetting of conventional spray dried milk powder with wet steam to moisture levels of 10 to 20 percent. The wet mass is then dried in hot air to approximately 3 percent moisture. The resulting product is composed of relatively large particles of low density, which disperse readily in water.
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22 May 1957

Book Reviews

Organic Synthesis. vol. I, *Open-Chain Saturated Compounds;* vol. II, *Open-Chain Unsaturated Compounds, Alicyclic Compounds, Aromatic Compounds.* Vartkes Migrdichian. Reinhold, New York; Chapman and Hall, London, 1957. 1822 pp. $35 per set (not sold separately).

In these days when the study of reaction mechanisms occupies an ever-increasing proportion of the published work on organic chemistry, the appearance of a treatise devoted to the factual information concerning organic synthesis can only be welcomed. The author's stated aim of "completeness" also is commendable, but obviously even an 1800-page treatise on so vast a subject can be complete only if considerable flexibility in definition is allowed. This two-volume work is somewhat similar to Richter's classic treatise, and a third volume is contemplated on heterocyclic compounds. In view of the well-known *Organic Syntheses* series, the title of Migrdichian's work appears to be somewhat unfortunate.

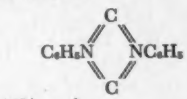
The author's division of subject matter into 30 chapters is, for the most part, conventional. However, it would have seemed preferable to place the chapter on Friedel-Crafts reaction in volume II rather than in volume I and the material on carbohydrates in a separate chapter rather than with alcohols in chapter 1. Volume I contains separate chapters devoted to the Grignard reaction, organometallic compounds, and organic compounds of nonmetals and metalloids, while volume II contains special chapters on diene synthesis and on aromatic diazo compounds. Only 105 pages are devoted to alicyclic compounds, including the steroids.

Following each chapter is a long list of literature references, which taken together comprise a total of some 250 pages. Chapter 30 contains 719 numbered references, many of which contain more than five literature citations. Volume II ends with an 88-page index. Both volumes contain innumerable structural formulas. Most subjects are discussed in gratifying detail. Experimental descriptions are supplied, both for general and for representative special methods of synthesis. The factual material appears to be authoritative. That one man could compile such a tremendous amount of information is indeed remarkable.

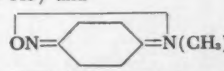
To note isolated faults in a treatise so ambitious in scope is, of course, easy. On the other hand, no one reviewer could possibly be competent to present a critical review of all parts of such a work. Although these volumes contain a veritable wealth of information which no organic chemist can afford to be without, they nevertheless exhibit a number of very serious faults. Prime among these is the woefully inadequate proofreading. This was performed so carelessly that it is imperative for the publishers and author to make amends before a second edition appears. The one and a half pages of *errata* do not include even a minute fraction of the total number of misprints, misspellings, errors in structural formulas, ambiguous names, and so forth. Some of these are so serious that they render entire sentences unclear. From sheer exhaustion I stopped listing all the typographic errors at the end of four chapters. A sampling of these errors includes: "iaoms" (page 5); "acetals of formaldehyde appears . . . ." (page 46); "glyoxol" (page 104); "NaCH" (page 145); "thineyl" (page 184); "the reaction is initialed by . . . ." (page 866); "dially shows an exceptional behavior . . . with perbonzoic acid" (page 897); "6-hydroxyhydrindene couples at position 4" (page 1519); "the reaction of chlorine with benzaldehyde results in . . . formation of benzyl chloride" (page 1551). In my copy, pages 579 to 610 are missing, and pages 547 to 578 appear twice.

No consistent scheme of nomenclature is followed. The choice of unfortunate or ambiguous—and at times incorrect—names, coupled with typographic errors, leads to incongruous expressions such as "AiH_3" (page 12); "expoxide" (page 27); "p-methylaminobutyraldehyde" (page 118); "1,3-diphenyl-2-acetoxy-1,3-dione" (page 119); "bisulfite compound of 2-methyl-5-isopropylcyclohexane" (page 144); "2-hydroxy-2-naphthaldehyde" (page 208); "β-hydroxynaphthaldehyde" (page 218); "tertiary butyl ester has been acylated . . . ." (page 341); "propylaldehyde" (page 371); "pentyl dimagnesium bromide, like butylenedimagnesium bromide, reacts . . . ." (page 576); "cyclohexanoic acid" (page 883); "bis-isobutene ethylene" (page 891); "phenylhexyl acid" (page 917); "tert-isobutylene" (page 920); "diazobenzene chloride" (page 1284). "Tetramethylethylene hydroxy ethylamine" (page 89) is the name given to $(CH_3)_2COHCNH_2(CH_3)_2$. Errors in formulas appear on pages 42, 51, 93, 141, 170, 175, 564, 632, 1095, and at many other places.

Although "theoretical discussions are beyond the scope of this work," grossly incorrect or misleading formulas nevertheless should not appear. However, formulas with pentacovalent nitrogen occur repeatedly—for example on pages 102, 181, 1346, and 1466. Sulfonium salts (page 93) and oxonium salts (pages 80 and 1286) are shown with all bonds covalent. The author was extremely uncritical to reproduce, without comment, formulas such as



(page 445) and



(page 1437). Ring structures are written for azoxy compounds (page 1623), azides (page 1630), and diazoalkanes (pages 1633 and 1635). Sterically impossible formulas with fused 3- and 4-membered rings appear for piazthiol (page 1446) and methylanthranil (page 1449).

The author's claim that "reaction mechanisms receive mention only when well-nigh complete agreement exists on their essential correctness" is misleading and is not fulfilled. The few theoretical discussions are very poorly written. The discussion of the mechanism of coupling of diazonium salts contains vague and incorrect ideas: "The reaction, which is bimolecular, is one of condensation between the undissociated, polarized diazo compound and the aromatic body in an activated state, in which a hydrogen atom has acquired an induced positive charge" (page 1511). "It would appear that in the [coupling] reaction with phenols, it is the free phenol formed by the dissociation of the phenolate that couples with the diazo compound" (page 1513).

The article cited for the mechanism of the Perkin reaction (page 1389) was published in 1928; the latest reference for the mechanism of the Hofmann reaction (page 381) is dated 1911. The mechanism of addition of hydrogen halide to olefins is discussed in these words: "The normal reaction may be considered the result of the attack of a

positive halogen ion on the positive carbon atom, following the addition of a proton to the negative atom" (p. 863). Statements like "the mechanism of the [Willgerodt] reaction has not been elucidated" (page 244) would seem to require elaboration. Curved arrows to illustrate reaction mechanisms are used only rarely, and in one case (page 1294) the resulting formulas are garbled. The Elbs persulfate oxidation is mistakenly called the "Dakin oxidation" (page 1277), while the latter reaction is presented (page 1281) without its "name." Reactivity of halogen compounds is discussed in chapter 11 with no mention of theory. An outdated theoretical discussion of chelation in *o*-hydroxy aromatic ketones is given on page 1368, along with a garbled structural formula.

It is to be expected that a treatise such as the present one will not be up to date with the literature. In general, few references later than 1950 are given. Thus, in chapter 25 only one article later than 1947 is cited, and in chapter 2, only one article later than 1949. A given paper sometimes is cited in the same chapter under different numbers and sometimes is listed twice under the same number. Certain interesting reactions are presented—for example, at the top of page 476—with no reference to the literature.

I noticed many cases where space was wasted because of needless repetition of subject matter. For example, the reaction depicting the oxidation of an acetylene derivative with selenium dioxide is given on page 999 and again on page 1022 and is mentioned in words on page 1001; the related literature reference appears as Nos. 541, 408, and 270. The reaction of diphenyl ether with hydriodic acid is described in almost identical words at two different places on page 1285. Formulas illustrating the conversion of benzoquinone to the triacetate of hydroxyhydroquinone are given on pages 1307 and 1310.

Some index entries under *acetaldehyde* and under *acetal* appear to have been interchanged. Diiodoacrylic acid is listed under *D* and also under *A*, while dimethylketene appears under *D* but not under *K*.

While the relative amount of space allotted to various topics justifiably is a point on which few would agree, it nevertheless seems unfortunate that only one page (901) is devoted to polymerization of unsaturated compounds and only three and a half pages (835–838) to the preparation of alkenes by dehydration of alcohols and by pyrolysis of esters. The addition of sulfur chloride to ethylene is mentioned (page 876) without noting that the product is called "mustard gas." Apparently no discussion of DDT as such is presented anywhere in the work.

As soon as the serious shortcomings are overcome, Migrdichian's treatise seems certain to take its place among the indispensable reference works of organic chemistry. Even with these shortcomings, the work is tremendously valuable to all experienced organic chemists. However, the uninitiated is certain to experience considerable confusion and dismay in using these volumes in their present form. Without deemphasizing the rightful emphasis on factual knowledge, this work could be unified and improved by a discussion of many of the facts in terms of basic theoretical concepts. Such an approach would not necessarily add any pages and, indeed, might make possible considerable saving of space. Perhaps the main merit of the electron theory of organic chemistry is that its judicious use permits a satisfying unification of many facts previously considered unrelated or anomalous.

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Battle for the Mind. A physiology of conversion and brainwashing. William Sargant. Doubleday, Garden City, N.Y., 1957. 263 pp. + plates. $4.50.

William Sargant has written entertainingly about 18th-century Methodism, Voodoo, the Eleusinian mysteries, and North Carolina snake handlers, coupling these with accounts of combat fatigue, the London blitz, miscarriages of British justice, and Chinese Communist thought reform. Sargant has a catholic enthusiasm for Pavlov, and he would have us believe that the great Russian explained all of these very simply. He draws some interesting parallels, even though he has to draw some of them a long way. This book should be labeled "speculation" and read with this in mind; otherwise the reader may come away with some mistaken ideas.

It is quite true that the effects of anxiety, fatigue, loss of sleep, hunger, pain, debilitation, and circulatory disturbances may reduce a man to a state of mental dullness, loss of discrimination, confusion, pliability, and increased suggestibility. It is also true that the Communist state police know this and make use of their knowledge in extracting confessions. But these effects, by and large, are transient and disappear when the normal physiological state is restored. It is not true that Communist police can alter beliefs at will. I have gone over the evidence on this point at some length and am satisfied that the victims of the "purge trials" of the 1930's and 1950's, the various foreigners "tried" by China and the satellites, and the American airmen who "confessed" to bacteriological warfare in Korea, when they had recovered from the ordeal of interrogation, were generally aware of the extent to which their "confessions" were untrue and "cooperated" with their captors because it seemed to be the wisest course open to them in the extremely difficult situations in which they found themselves.

Sudden, emotionally charged, and relatively permanent conversions to Communism do occur, and sometimes they happen to people who were formerly strongly anti-Communist. They are rare, and the overwhelming majority occur outside of prisons, in a variety of unpremeditated circumstances, to people who seem to have a need for religious conversion, and who also have a propensity for being reconverted to other faiths at a later date. The very rare conversions among Communist captives seem to occur only among such susceptible people. The mass appeal of Communism, however emotionally charged it may be, is based on its promise to better the lot of those who see themselves as poor, downtrodden, and exploited. Such people, along with others who identify with them for idealistic or practical reasons, support the party with varying degrees of irrationality and dedication, like that of supporters of other dynamic political movements.

There is no good evidence that the Communists have developed indoctrination techniques superior to those used by non-Communist nations, or based on new and scientifically devised principles. By a mixture of strict control, limited information, didactic teaching, and reward-and-punishment, they can produce a great deal of compliant behavior among their captives and create some awareness among them of the ostensible social and political goals of Communism; but the Communist record for producing firm conversions among the skeptical or hostile is dismal. Among all of the American military prisoners in Korea, including the notorious "21 who stayed," I can think of less than a half-dozen who were "converted" to Communism (using any reasonable definition of this term), and even these were people not previously hostile to it. A diligent investigation of young Hungarian workers, students, and intellectuals—members of Communist groups who spent their adolescence in Communist schools and some of whom spent years in the hands of the State Defense Bureau (AVH)—has uncovered some misinformation among them, and a vast amount of skepticism and hostility toward the Communist regime, but nothing remotely resembling effective methods of thought control.

Communist state police methods are just that: police methods. The evidence indicates that scientists did not design

them and do not participate in them. Pavlov made great contributions to neurophysiology, some of which have some applicability to the understanding of prison experiences, as they do to the understanding of many other types of experience; but Pavlov's hypotheses about the temperamental characteristics of dogs, and the relation of these to certain types of conditioning procedures, provide only the dimmest sort of illumination for the complex social and political phenomena of modern times.

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Glossary of Geology and Related Sciences. J. V. Howell, coordinating chairman. American Geological Institute, Washington, D.C., 1957. x + 325 pp. $6.

The idea for this *Glossary* was formed in early 1950, work was started on it 1 Mar. 1953, and it was published in June 1957. With a staff of about 90 specialists, it covers some 25 geologic fields, going from "*a*, direction . . ." to "*zygote*, a fertilized egg. . . ." J. V. Howell and his group have accumulated a great number of terms, and although I have not read them all, those I have checked are well handled and correct. Lynn M. Nichols, of the *Oil and Gas Journal*, is technical editor and has edited all of them, to the betterment of the book.

There has long been a need for this *Glossary*. There are perhaps five dozen dictionaries and glossaries in which various geologic terms are defined, but this is the first one that covers the field and related sciences. (This covers some 14,000 terms.) Everyone connected with the project should feel proud of a good job well done. It is expected that this edition will be exhausted before long, and additional terms will be included in the next. We all need the book and should use it.

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Quantum Chemistry, an Introduction. Walter Kauzmann. Academic Press, New York, 1957. 744 pp. Illus. $12.

The author of this book set out to produce an elementary textbook. In this he has succeeded, with some spectacular pedagogical features. Mathematical operations for important elementary topics are written out in unusually great detail, and all pertinent mathematics is presented in connection with extremely clever examples from classical mechanics before quantum mechanics is introduced. Because of the patient presentation of the mathematical methods and because of detailed discussions of concepts, this adds up to a long book: 744 pages of small and very small type, 230 problems, 254 references, 158 figures, 47 tables, and more than 2800 equations. In spite of its length, the book is less complete in coverage, less useful as a handbook to the chemist who is using quantum mechanics in his research, and less complete in the presentation of details of advanced topics than are certain other textbooks in this field. However, as an introductory textbook for the average senior or graduate student in chemistry, this book has many extremely attractive features, and it should be widely useful.

In the first 150 pages there are problems in classical mechanics which give rise to the same mathematical operations that are met with later in quantum mechanics. For example, surface harmonics, including *s*, *p*, *d*, *f*, and so on, notation, is introduced in terms of the normal modes of vibration of the ocean on a completely flooded planet. Also a correlation diagram, in going from the normal modes of a square membrane to the normal modes of a round membrane, illustrates correlation diagrams in general, perturbation theory, and the reason for proper linear combination of degenerate normal modes. Similar illustrations are given for the variation method, symmetry operations, systems with strong or weak coupling, and so on.

With all difficult mathematical operations already covered in the treatment of easily visualized mechanical systems, the author is able to concentrate in the next 400 pages on the physical and chemical concepts of quantum chemistry. The topics covered are the usual ones: the Schroedinger equation and its exact solution and interpretation for simple systems, the uncertainty principle, angular momentum operators, atomic systems (two long chapters), molecules (two long chapters), van der Waals forces, and time-dependent processes. On these topics and problems the book is critical, stimulating, and up to date.

At this point, on page 546, we encounter a second book, based on the same plan as the first but carrying out this pattern less successfully. The subject of this second book is the quantum theory of light. The first 90 pages are devoted to the "classical theory of optics," largely the Lorentz theory of electrons and their interaction with light waves. The last chapter is devoted to patching up this theory with quantum considerations. Surely the author would have been excused if at the end of his book he had indulged himself in a short, difficult chapter on this, his field of research. Instead, we have a very long section which attempts to make the subject simple and easily visualized; one gets the impression that this section is artificial, specialized, and not of the same polished quality as the rest of the book.

Often a student comes up with one or another of two unfortunate attitudes toward quantum chemistry. On the one hand, he may be repelled by the mathematical details; he may want a nonmathematical version of quantum mechanics; and he may memorize several words, some of them having many syllables. On the other hand, a student may work through the treatment of the hydrogen atom and a few other cases; he is thrilled by the success of the theory, and at once he wants to hang up his laboratory apron, throw away his test tubes, and start calculating the answer to his technical chemical problems. In fine philosophic passages, Kauzmann consciously combats both of these profitless attitudes. The point is firmly made that nonmathematical quantum mechanics is like dehydrated water; the student is sternly told that he must master the mathematical methods, derivations, and operations in order to understand what has been done, what can be done, and what cannot be done with present techniques. The early optimist is warned that in spite of all the mathematics one can learn and even with high-speed computers, one does not in the foreseeable future expect quantitative theoretical solutions to routine chemical problems.

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Biochemical Problems of Lipids. Proceedings of the second international conference held at the University of Ghent 27–30 July 1955. G. Popják and E. Le Breton, Eds. Interscience, New York, 1957. iv + 505 pp. Illus. $10.75.

This book is a compilation of some 69 of the 80 papers presented at the second international conference. Most of these papers are in English, but quite a few are in French and German. The breadth of subjects covered by the book is indicative of the broad field of interests in lipid chemistry.

Part I is devoted to physical and chemical properties of the lipids, methods of separation, and structures. Of special interest is the article by A. T. James and A. J. P. Martin on gas-liquid chromatography as it is used in the separation and identification of methyl esters of saturated and unsaturated fatty acids. This procedure is perhaps the most exciting in the field of lipid chemistry at the moment.

Part II is concerned with metabolism

and biosynthesis, enzyme systems. The paper entitled, "Further studies on the biosynthesis of cholesterol and squalene," by Cornforth *et al.*, deserves special mention because of the probable significance of cholesterol synthesis in atherosclerosis. The final paper of this section is the report of an international committee on "Nomenclature of enzymes of fatty acid metabolism."

Part III is devoted to phospholipids and transport. Of special interest are a report by E. H. Ahrens, Jr., on "Fatty acid exchanges during fat digestion in the human intestine" and an article by M. G. Morehouse, W. P. Skipski, R. L. Searcy, and Leonard Spolter on "Absorption and distribution in the rat of lipids utilizing labelled glycerides and components." The article by J. Glover and C. Green on "Studies on the absorption and metabolism of sterols: mode of absorption" is of current interest.

Several papers in part IV are especially timely. These are "Minor constituents of unsaponifiable fractions of kidney, liver and other tissues from various species," by R. A. Morton; "Rôle de la choline a l'égard de la toxicité de certains mélanges lipides-cholestérol," by J. Raulin; "The biological value of various natural oils and fats," by H. J. Thomasson; "Function and metabolism of essential fatty acids," R. T. Holman; and, finally, "Action de l'héparine *in vitro* sur les lipides et les proteines du sérum sanguin," by Colette Magis.

It is not possible in a book of this type, covering so many subjects, to review any papers in detail. However, this volume should be on the required list for every lipid chemist and especially for graduate students working in this field.

J. B. Brown

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Experimental Research on Ageing. Symposium of the Biological and Medical Research Committee of the International Gerontological Association's European Section. Basel, 4–7 Apr. 1956. F. Verzár, Ed. Birkhäuser, Basel, Switzerland, 1956. 290 pp. F. 34.

This report of a symposium organized by F. Verzár and J. F. Danielli, under the auspices of a committee of the International Gerontological Association's European Section, is of special value, since the participants have presented observational data to support their points of view. It offers an excellent perspective of the interests of European investigators in research on aging.

Of the 40 papers published, the first five offer the views of R. E. Tunbridge and D. A. Hall (Leeds), I. Banga, J. Baló and D. Szabó (Budapest), Verzár (Basel), and N. R. Joseph and F. Bourlière (Paris) on age changes in connective tissue. These papers summarize, in a lucid fashion, the areas of agreement and disagreement among these investigators. With increasing age, collagen undergoes changes which are reflected in its chemical and physical properties. Danielli and G. H. Bourne (London) considered the potential role of somatic mutations in aging and reviewed briefly age changes in mammalian tissue cells. The importance of the interrelations between the functions of cells of a given tissue with other cells of the body was stressed. Although attractive, the hypothesis that aging is attributable to somatic mutations is highly speculative, since calculations must be based on mutation rates in the germ cells in the absence of data on somatic cells. O. Mühlbock (Amsterdam) summarized data from his genetic studies on mice to demonstrate that advanced parental age reduced the frequency of spontaneous mammary and hepatic tumors in the offspring. L. Brull and C. Keil (Liége) showed that fatness in mice increased regularly with age except in extreme old age. They concluded that mice behave like human beings—they keep on eating too much after they are grown.

About 14 papers were concerned with age changes in the functional capacities of various organ systems in mice, rats, and human beings. These varied from reports on structural changes in the senile mouse ovary (P. J. Thung, Amsterdam), and age differences in the response of body temperature of the rat to cold environments (F. Hügin and Verzár, Basel), to changes in carbohydrate (W. E. J. Jessop, Dublin, and H. Baur, Basel), protein (J. Rechenberger, Leipzig), and lipid metabolism (G. Schettler, Marburg) in the human being. Arteriosclerosis was the subject of papers by E. Greppi, G. Scardigli, G. Guidi, F. M. Antonini (Florence) and F. H. Schulz (Leipzig). Other clinical studies on protein metabolism (W. Schulze, Ludwigshafen), water metabolism (O. Olbrich and E. Woodford-Williams, Sunderland), blood coagulation (T. Geill, Copenhagen), aging in the central nervous system (M. Bürger, Leipzig), vitamin treatment of mentally disturbed old people (L. Van der Horst, Amsterdam), and blood sedimentation (J. A. Huet, Paris) were also reported. V. Korenchevsky (London) developed, in detail, his theory of autointoxication as one of the causes of aging. Olbrich and Woodford-Williams were unable to reduce nitrogenous waste products in the blood by daily intravenous infusions of saline in old subjects. A. T. Welford (Cambridge) critically examined current theories of age in learning ability. E. R. F. W. Crossman and J. Szafran (Birmingham), using card-sorting tests of increasing complexity, found that the easy tasks showed greater age differences than did the more difficult tasks. This is a new observation which led the investigators to present an interesting hypothesis based on the concept of "internal noise" in the nervous system.

Although many "old hands" in gerontological research contributed to the symposium, a number of investigators who were new to the field of aging were represented. This is an indication of the growing recognition of the importance of aging research among scientists from many disciplines.

The book offers thoughts and hypotheses about aging which should serve as a further stimulus to research. It differs from other symposia in that only minor reference is made to the discussion. The published discussion is usually limited to a series of questions with specific answers, so that the reader does not get full benefit of the thinking of the group. Unfortunately, the book does not contain a subject index. However, the volume is a "must" for anyone who wishes to be informed about current research on aging in European laboratories.

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A Revision of the Australian Chafers (Coleoptera: Scarabaeidae: Melolonthinae). vol. 1. E. B. Britton. British Museum (Natural History), London, 1957. viii + 185 pp. Plates. £4.

Volume I of this much needed revision of Australian chafers is presented in 185 pages, with 25 text figures and 42 plates with 499 line drawings. The volume is especially valuable, since E. B. Britton was unusually fortunate in being able to examine a high percentage of the types of Australian Melolonthinae, the British Museum itself owning at least half of the types of the 1389 known species. He was privileged also to spend the greater part of a year in Australia, studying types in the five Australian museums owning such specimens.

In the first volume, 157 of 184 previously described species are reduced to 136 through synonymy, and 67 new species are added, to bring the total to 203 species. These species, occurring on the Australian mainland and associated islands, including Tasmania, are described and presented in well-constructed keys to tribes, genera, and species.

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New Books

Histology. Arthur W. Ham. Lippincott, Philadelphia, Pa., ed. 3, 1957. 909 pp. $11.

Industry and Technical Progress. Factors governing the speed of application of science. C. F. Carter and B. R. Williams. Oxford University Press, London, 1957. 252 pp. $4.

Mathematical Analysis. A modern approach to advanced calculus. Tom M. Apostol. Addison-Wesley, Reading, Mass., 1957. 565 pp. $8.50.

The Measurement of Meaning. Charles E. Osgood, George J. Suci, Percy H. Tannenbaum. University of Illinois, Urbana, 1957. $7.50.

Mosses of Indiana. Winona H. Welch. Bookwalter, Indianapolis, Ind., 1957. 478 pp.

No Frontier to Learning. The Mexican student in the United States. Ralph L. Beals and Norman D. Humphrey. University of Minnesota Press, Minneapolis, 1957. 159 pp. $3.25.

Prehistoric Man. A. Lerio-Gourhan. Philosophical Library, New York, 1957. 129 pp. $4.75.

Recent Progress in Hormone Research, vol. XIII. Proceedings of the Laurentian Hormone Conference 1956. Gregory Pincus, Ed. Academic Press, New York, 1957. 654 pp. $12.80.

Survey of Biological Progress, vol. III. Bentley Glass, Ed. Academic Press, New York, 1957. 345 pp. $7.50.

Synthetic Methods of Organic Chemistry, vol. 11. W. Theilheimer, Ed. Karger, Basel; Interscience, New York, 1957. 510 pp. $20.

Tables of Angular Distribution Coefficients for Light-Scattering by Spheres. Chiao-Min Chu, George C. Clark, Stuart W. Churchill. Engineering Research Institute, University of Michigan, Ann Arbor, 1957. 58 pp. $3.

Biology of the Treponematoses. Based on studies carried out at the International Treponematosis Laboratory Center of Johns Hopkins University under the auspices of the World Health Organization. WHO Monogr. Ser. No. 35. Thomas B. Turner and David H. Hollander. World Health Organization, Geneva, 1957. 278 pp. $6.

The Development and Meaning of Eddington's 'Fundamental Theory.' Including a compilation from Eddington's unpublished manuscripts. Noel B. Slater. Cambridge University Press, Cambridge, Mass., 1957. 311 pp. $7.50.

Fall Out. Radiation hazards from nuclear explosions. A. Pirie. MacGibbon & Kee, London, 1957. 160 pp. 12s. 6d.

Fenestella from the Permian of West Texas. Geological Society of America Memoir 70. M. K. Elias and G. E. Condra. Geological Society of America, New York, 1957. 167 pp.

General Zoology. Tracy I. Storer and Robert L. Usinger. McGraw-Hill, New York, ed. 3, 1957. 670 pp. $7.50.

Handbuch der Physik, vol. XXVIII, *Spectroscopy II.* S. Flügge, Ed. Springer, Berlin, 1957. 454 pp. DM. 98.

The A-B-C of Electrons, Atoms, and Molecules. Their mechanical actions and functions and their simple ratios in mathematical terms. Frank X. Graser. Greenwich, New York, 1957. 104 pp. $3.

Advances in Pest Control Research, vol. I. R. L. Metcalf, Ed. Interscience, New York, 1957. 521 pp. $11.

L. P. Alford and the Evolution of Modern Industrial Management. William J. Jaffe. New York University Press, New York, 1957. 387 pp. $5.

Quantitative Organic Analysis. James S. Fritz and George S. Hammond. Wiley, New York; Chapman & Hall, London, 1957. 316 pp. $6.

The Relativistic Gas. J. L. Synge. North-Holland, Amsterdam: Interscience, New York, 1957. 119 pp. $4.50.

Rheumatoid Arthritis. A definition of the disease and a clinical description based on a numerical study of 293 patients and controls. Charles L. Short, Walter Bauer, William E. Reynolds. Published for The Commonwealth Fund by Harvard University Press, Cambridge, Mass., 1957. 490 pp. $7.

Semiconductors. Their theory and practice. G. Goudet and C. Meuleau. Translation by G. King of *Theorie et Pratique des Semiconducteurs.* MacDonald & Evans, London, 1957 (order from Essential Books, Fair Lawn, N.J.). 334 pp. $18.90.

Set Theory. Felix Hausdorff. Translated from the German, ed. 3, by John R. Aumann *et al.* Chelsea, New York, 1957. 352 pp. $6.

Soil—Plant Relationships. C. A. Black. Wiley, New York; Chapman & Hall, London, 1957. 339 pp. $7.

A Student's Histology. H. S. D. Garven. Livinston, Edinburgh, 1957. 662 pp.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Analysis and *Operational Research.* Two series of papers reprinted from *Research,* vol. 9, 1956. Butterworths, London, 1957 (order from Interscience, New York). 69 pp. $2.50; 40 pp. $2.

An Archaeological Survey of West Central New Mexico and East Central Arizona. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University, vol. 44, No. 1, Edward Bridge Danson. 133 pp. $4.50. *A Chancay-Style Grave at Zapallan, Peru.* An analysis of its textiles, pottery, and other furnishings. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University, vol. 50, No. 1. S. K. Lothrop and Joy Mahler. 38 pp. $2.50. *Peabody Museum of Archaeology and Ethnology, Harvard University, Ninetieth Report.* 55 pp. Peabody Museum, Cambridge, Mass., 1957.

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Meetings and Societies

High-Energy Physics

The seventh annual Conference on High Energy Nuclear Physics was held at the University of Rochester, Rochester, N.Y., 15–19 Apr. This series of conferences was initiated 7 years ago by the University of Rochester, aided by local industrial concerns, with the intention of bringing together a small and intimate group of specialists in order that they might thrash out problems of mutual interest in an informal atmosphere. The conferences have been held annually in Rochester since then, and the scope, duration, attendance, and sponsorship have expanded at a rate commensurable with the rapid development of the field of high-energy physics. This year's conference was attended by approximately 300 invited guests, representing laboratories from 24 countries. The sponsors were the National Science Foundation and the University of Rochester, in cooperation with the International Union of Pure and Applied Physics, the U.S. Atomic Energy Commission, the U.S. Air Force Office of Scientific Research, and the U.S. Office of Naval Research. Further support was provided by several national industrial concerns in addition to the usual help from local Rochester industries.

Because this conference has become known internationally as the ultimate source of up-to-the-minute information in a very rapidly developing field, it has been increasingly difficult to maintain the small and intimate character of the original meeting. In order to allow for informal discussion, two afternoons were originally left open in the tentative program. However, the flood of contributions made it necessary to schedule sessions on both of these afternoons. In spite of the tight schedule and large attendance, the meeting had an informal flavor. Much too little time was devoted to discussion from the floor; nevertheless, the sessions were enlivened by an occasional verbal joust.

There were, altogether, ten half-day sessions in the 5 days. The first session had the title "Structure of the nucleon," although, as the chairman of the session, R. E. Peierls, remarked, the entire field of high-energy physics is concerned in one way or another with this question. The introductory talk by G. Chew was largely devoted to the structure of classical pion theories outside the core radius (about $\frac{1}{4} \times 10^{-13}$ cm). He pointed out that the classical pion theory, with appropriate technical modifications, seems to describe phenomena associated with the domain of large distances (beyond 10^{-13} cm) rather well and that the intermediate region is not quite so well understood, and he described the core as that "dark and forbidding region." Experimental methods for getting at the intermediate and outer structure were discussed in contributed papers by Hofstader (scattering of high-energy electrons) and by Bernardini and Telegdi (scattering of high-energy gamma radiation). Contributed theoretical papers were largely concerned with the problem of S-wave pion-nucleon scattering.

The second session was devoted to "Pion reactions," mainly from the experimental side. This is now generally referred to as "classical" pion physics, although it was the very frontier of high-energy physics at the first conference. Recent experimental work was surveyed by J. M. Cassels, who emphasized the quantitative results on the lower energy side (pion energies below 700 Mev) and their bearing on the structure of the nucleon in the intermediate and outer regions. In particular, he, as well as Chew, emphasized that the renormalized pion-nucleon coupling constant, f^2, is attaining the status of a fundamental constant of physics. Scattering of pions by nucleons seems to fix f^2 at about 0.08, in the conventional units; however, Cassels called attention to serious discrepancies with respect to this and to other aspects of the theory of the nucleon structure. In particular, the results on photopion production from protons do not seem to be in accord with the theory. A number of new experimental results were presented in contributed papers, the stress being laid on increased accuracy of the data at lower energies and the extension of the rough data to higher energy.

The third session was devoted to the "Nucleon-nucleon interaction," the emphasis being on attempts to fit both the low- and high-energy data on the two-nucleon system with a potential containing a minimum number of parameters. R. E. Marshak introduced the subject by surveying recent work and presenting new results based on a potential built around the pion-nucleon theory. This potential alone does not give agreement with the data at high energy, but Marshak demonstrated that the addition of a spin-orbit interaction to the potential serves to bring about good agreement over the entire energy range. The appropriate value of f^2 is close to that obtained from pion-nucleon scattering. There is no theoretical justification for the introduction of the spin-orbit term, and the parameters appearing therein are not given any fundamental interpretation. R. M. Thaler described an analysis of the data, using a very similar, but completely phenomenological, potential. Most of the other contributed papers were presentations of the increasingly accurate data from nucleon-nucleon scattering and polarization experiments in the (laboratory) energy range from 100 Mev to 6 Bev.

The next meeting was devoted to "Theoretical physics." J. Schwinger led off with a discussion of the structure of Green's functions (threefold expectation values) in field theory. The object was to show that certain analytic properties of the functions follow from a simple specification of the boundary conditions. He was followed by G. Källén, who discussed the same problem from a somewhat different (that is, contrary) point of view. A series of contributed papers on dispersion relations in field theories comprised the principal part of the remainder of this session.

The fifth session, concerning "High-energy collision phenomena," started with a survey of the experimental and theoretical situation by R. Serber. He came to the conclusion that a Fermi statistical model, augmented by taking special account of the influence of the isobaric state of the nucleon, can give a rough account of the multiple pion production processes at laboratory energies. However, he found that the present situation with respect to strange particle production is somewhat confusing. A number of new experimental results on the production of strange particles were presented in contributed papers but did not allay the confusion. In particular, the production of K-mesons by gamma rays on protons was described by R. L. Walker.

L. Alvarez led off the next gathering with a summary of the past year's experimental developments concerning "Strange particle interactions." Data have been amassed at a tremendous rate during this period. Among other things, this was the year in which both the existence of the long-lived neutral K-meson

(suggested by Pais and Gell-Mann) and the existence of the Σ^0 hyperon were firmly established. Alvarez also presented extensive data on lifetimes, masses, and interactions with nucleons of strange particles. He was followed by a series of contributed papers describing very recent results on K^-, K^+, K^0, and Σ^- interactions with nuclei. The new, quantitative work on the cross sections for K^+ and K^- scattering from nucleons makes possible the beginning of a theoretical discussion of the interactions between K-mesons and nucleons.

The big news of the year in physics was, of course, that concerning the nonconservation of parity. The discovery was inspired by observations on the decay properties of K-mesons, which are strange particles appearing in high-energy phenomena. However, the discovery was made in the domain of low-energy nuclear physics—that is, in beta decay. The connection between the two is simply that both K-meson decay and beta decay are caused by interactions that are classified as "weak." In her talk during the seventh session, C. S. Wu's apt characterization of the situation was this: "My being invited here is solely on the strength of the weakness of the beta decay." In fact, the topic, "Weak interactions," of this session was not included in the original program, which had been prepared before the results on parity were obtained. In view of the very few months that intervened between the time of the discovery and of the conference, the amount of experimental work that had been done in the field was impressive. T. D. Lee, in his introductory talk, surveyed this work and discussed its theoretical interpretation, with special emphasis on the two-component neutrino theory suggested first by Landau and, in a somewhat novel form, by Salam and then, independently, by Lee and Yang. His was followed by several talks on beta-decay experiments related to the parity question. These included a summary by Miss Wu, which was followed by a series of contributed papers on meson-decay experiments related to parity conservation. Of particular interest is the possibility of measuring accurately the magnetic moment of the muon, which was discussed by L. M. Lederman, who described the work of both the Columbia University group and the Liverpool group.

Conclusions strongly favoring the two-component neutrino theory were drawn throughout this session. It is interesting to note that, in the 2 months following the conference, further experimental results have cast serious doubt on this conclusion and have led to a very confused picture of the beta-decay situation.

The eighth meeting was a catchall for contributions related to strange particles, including discussion of the decay modes, lifetimes, and branching ratios of these particles. There were also several papers concerned with hypernuclei, including a "world survey" by V. Telegdi.

With but one exception, the ninth session was devoted to contributed theoretical papers related to "Strange particles and weak interactions." The exception was J. M. Cassels, who apologized "for introducing an experimental peasant note into this otherwise very refined discussion" and then proceeded to describe experiments leading to the very puzzling fact that the decay of a pion into electron plus photon occurs, if at all, with a branching ratio less than 2×10^{-5}. Two papers of general interest were those of M. Gell-Mann and J. Schwinger, describing attempts to universalize the scheme of interactions between nucleons, hyperons, pions, and K-mesons—a game initiated by Schwinger about a year ago, following a pattern set a few years earlier by Pais. Other papers described theoretical work in progress.

The final session concerned "Antibaryon phenomena"—in particular, antiprotons and antineutrons. Despite the optimistic title of the session, no one reported an identification of an antihyperon. O. Chamberlain surveyed recent experimental work on antinucleons, including measurements of production and interaction cross sections as well as a discussion of the character of antinucleon annihilations in emulsions. Subsequent contributed experimental papers treated these subjects in more detail. The theoretical papers were concerned principally with the explanation of the interaction cross section of antinucleons with nuclei in terms of the interactions with nucleons. It seems that a simple optical model is capable of giving at least a rough fit to the data, but the large value of the elementary (antinucleon-nucleon) cross section has yet to be explained.

Aside from the exhaustion produced by the conference (ostensibly, everyone attended every session), the only disappointment was the absence of delegates from the U.S.S.R. Several were expected up to the last minute, but they cabled that the task of getting started with their new 10-Bev machine was so pressing that the trip was impossible. It is to be hoped that they will have many new and interesting results to present at the next conference.

For the first time since the beginning of the series, the next conference will not be held at the University of Rochester. Instead, CERN is planning to play host to a similar conference in Geneva, and the conference will return to Rochester the following year. This seems a good occasion to express the appreciation of all high-energy physicists to R. E. Marshak and the University of Rochester for the imagination and initiative that made these conferences possible and for the tremendous amount of work that produced such successful results.

R. G. Sachs
University of Wisconsin, Madison

Royal Society of Canada

The 75th meeting of the Royal Society of Canada was held in Ottawa 10–12 June. A society symposium on "Our debt to the future" was held each afternoon, and the final address was given by His Excellency the Governor-General at dinner on the evening of 12 June. At this dinner, also, His Excellency announced that His Royal Highness Prince Philip had accepted an invitation to become an honorary fellow of the society.

The Royal Society of Canada includes fellows from the humanities, as well as from the sciences, and was founded on the joint experiences of the French Academy and the Royal Society of London. Messages of good will from these societies were presented at the dinner by the French Ambassador and the United Kingdom High Commissioner.

Sections of the society held meetings in the mornings only. Section III (mathematical, chemical, and physical sciences) held a symposium on "Symmetry," introduced by its president, H. S. M. Coxeter, who discussed "Crystal symmetry" and its generalizations. A number of miscellaneous papers on mathematics and chemistry were also read. Section IV (geological sciences) heard a presidential address by H. C. Gunning and held a symposium on "Hydrology," and a number of individual papers were read. Section V (biological sciences) was addressed by its president, W. H. Cook, on "Research in the biosciences: a mid-century perspective" and by T. W. M. Cameron on "Parasitology and the Arctic"; a posthumous paper by G. Lyman Duff on the "Aetiology and pathogenesis of arteriosclerosis" was also presented.

AAAS Finances: Report for 1956

The financial records of the American Association for the Advancement of Science are kept in two separate accounts. One—the Current Fund (or operating account)—shows the expenses of running the association's ordinary, continuing activities and the income that is devoted to those activities; the other—the Investment Account—includes funds that have been given to the association to endow prizes, to pay the cost of maintaining the membership of emeritus and life members, and to support research.

Current Fund

Operating receipts totaled $719,233.81 during 1956. They were divided as follows.

Annual dues paid by members	$306,003.52
Extra payments by members who wanted to receive both *Science* and *The Scientific Monthly*	22,237.15
Money transferred from the Investment Account to pay for subscriptions for emeritus and life members	3,568.50
Journal subscriptions from nonmembers	66,065.03
Sales of individual copies of journals	2,466.96
Advertising in *Science*	203,285.25
Advertising in *The Scientific Monthly*	11,598.03
Sale of symposium volumes	21,015.22
Miscellaneous sales, including journal binders, association emblems, and Microcard edition of *Science*	2,948.87
Annual meeting: registration fees, exposition space, advertising in program, and contributions	41,906.31
Income from investment of funds not needed in checking account	8,489.56
Rental income from third floor and garage of new building	11,350.65
Allowance for expenses incurred in administering grants	16,820.61
Miscellaneous receipts	1,478.15
Total	$719,233.81

These receipts amounted to $1227.96 more than the operating expenses. This amount, therefore, was the association's surplus for the year. The principal items of expense were

Printing and editing *Science* and *The Scientific Monthly*	$378,164.95
Editorial Board expenses and honoraria	6,422.17
Cost of selling advertising in the two journals	54,506.96
Printing and editing symposium volumes	21,807.12
Cost of emblems, binders, Microcards	1,735.26
Meetings of boards and committees	11,098.65
Contribution to Scientific Manpower Commission	1,000.00
Recruitment of new members (exclusive of salaries)	9,109.51
Expenses of the annual meeting	34,365.44
Press service for annual meeting	4,901.56
Allowances ($1 per member) to Pacific, Southwestern and Rocky Mountain, and Alaska Divisions	7,772.00
Expenses of AAAS sections	5,303.69
Administrative staff salaries and general expenses	121,950.28
Rental of temporary quarters during construction of new building	7,613.00
Building maintenance	23,744.60
Real estate taxes	9,643.05
Depreciation of building	13,691.40
Depreciation of furniture and equipment	2,796.58
Miscellaneous other expenses	2,379.63
Total	$718,005.85

Comparison of 1956 with 1955

Receipts in 1956 were $116,813.13 above those for 1955. Over half of the increase was derived from advertising in *Science*, $61,231. Other increases were noted in annual dues, $17,195; the New York meeting as compared with that in Atlanta, $14,435; increased activity in administering grants, $13,439; rental from the new building in excess of rental from the old residential buildings, $10,272; and nonmember subscriptions, $5439.

Operating expenses in 1956 were greater by $124,329 than they were in 1955. The largest increases were in the cost of housing the association's offices, the cost of publishing the association's journals, administrative expenses, and the cost of securing advertisements. The cost of renting office space during part of the year and maintaining the new building, including real estate tax and depreciation, resulted in increased expenses of $35,105. Printing and editing *Science* and *The Scientific Monthly* cost $33,744 more in 1956 than in 1955. Administrative and general expenses were $22,635 higher in 1956, and it cost $18,405 more to solicit advertising in the association's journals.

Investment Account

To keep them separated from current funds and grants for special activities, the association holds its endowment and investment funds in a separate Investment Account. Although the association has some leeway in the handling of these funds, ordinarily the income is used and the principal left intact. Disbursements during 1956 were as follows.

Income allocated to Gordon Research Conferences	$1,624.47
Transfer to Gordon Research director's fund	10,000.00
Newcomb Cleveland prize	1,000.00
Socio-psychological prize and expense	1,016.41
Grants to academies of science to use in support of research	4,371.00
Transferred to operating account to pay for journal subscriptions for emeritus and life members	3,568.50
Expenses of managing investments	1,794.97

The accompanying statement of receipts and disbursements from this account also shows that $119,704 was spent for the purchase of securities. This amount was derived from the sale of other securities, $99,884; from a payment from the estate of Margaret Smith Young, $11,811; from life membership fees, $3488; and in part from the investment income of $23,766.

At the end of 1956 the Investment Account showed assets of $451,368, of which $26,502 consisted of endowment for the Gordon Research Conferences and $424,865 was for the other purposes mentioned in the first paragraph of this report. The funds in the Investment Account were distributed as follows.

	Book value	*Market value*
Cash	$ 12,542.26	$ 12,542.26
U.S Government bonds	76,237.50	70,680.00
Other bonds	116,082.95	107,350.00
Preferred stocks	58,908.59	51,320.00
Common stocks	187,597.21	269,955.00
Total	$451,368.51	$511,847.26

Consolidated Balance Sheet

In order to give a view of the association's financial position, the figures from the Current Fund and Investment Account have been combined here. At the end of 1956, the consolidated balance sheet showed the following assets.

Cash	$ 147,315.17
Money owed to the association	35,433.99
Money invested in securities	804,783.40
Value of new building and land	886,155.46
Value of new furniture and equipment	46,690.84
Total	$1,920,378.86

Offsetting these assets, as they always must in a balance sheet, were liabilities, as shown in the following list.

Accounts payable to others	$ 115,408.37
Unexpended portions of grants from Carnegie Corporation, National Science Foundation, and General Electric Educational and Charitable Fund	101,067.37
1957 dues and subscriptions received, but for which members and other subscribers had not yet received journals or other services	300,867.75
Mortgage payable in 9.5 years	167,503.46
Endowment funds for prizes, research grants, life and emeritus members' subscriptions, and general purposes	421,555.75
Building fund (contributions and earlier surplus invested in the association's building)	718,652.00
Unallocated funds	95,324.16
Total	$1,920,378.86

Grants Received in 1956

Among the liabilities shown is an item of $101,067 which represented the unexpended portions of grants made to the association. The grants received are briefly accounted for in the following paragraphs.

From the Carnegie Corporation, the association received $100,000 on 1 July 1956. This amount was the second payment of a grant of $300,000 to support the AAAS Science Teaching Improvement Program. In addition, $88,337 was available representing the unexpended balance as of 1 Jan. 1956. During the year, a total of $130,184 was paid out for this program—including $77,085 to four centers for the study of the use of science counselors. The unexpended balance on 31 Dec. was $58,153.

For Conferences on Mathematics Instruction, the association received $6000 from the Carnegie Corporation. The unexpended balance on 31 Dec. was $4240.

The General Electric Educational and Charitable Fund granted the association $12,000 for a program for Regional Consultants on Science and Mathematics. The balance on 31 Dec. was $10,267.

The National Science Foundation followed up its 1955 grant during 1956 with a payment of $65,100 to continue on a larger scale the project of Traveling High-School Science Libraries. The balance on 1 Jan. had been $8946. On 31 Dec. there remained on hand $28,406.

Auditor's Report

A condensed statement of the association's finances for 1956, prepared by the firm of G. P. Graham and Company, is published herewith. Balance sheets and statements of receipts and expenditures are given separately for the Current Fund and the Investment Account. The portion of the auditor's report published here does not include funds for the Gordon Research Conferences. The conferences, after a continuous existence for 25 years, were incorporated as a separate unit during 1956.

HANS NUSSBAUM
Business Manager, AAAS

Washington 5, D.C., 25 June 1957

To the Council of the
American Association for the
Advancement of Science
Washington, D.C.

We have examined the balance sheet of the Current Fund of the American Association for the Advancement of Science as at 31 Dec. 1956, and the statement of revenue and expenditures for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying statements present fairly the financial position of the Current Fund of the American Association for the Advancement of Science as at 31 Dec. 1956, and the results of its operations for the year then ended.

G. P. GRAHAM & COMPANY
By G. R. BOWERS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE CURRENT FUND
BALANCE SHEET AS AT 31 DEC. 1956

Assets

Cash on deposit			$ 131,272.91
Imprest funds			3,075.00
Accounts receivable			35,433.99
Deposit with airline			425.00
Investments			392,459.90
Land			115,875.00
Building		$783,971.86	
Less allowance for depreciation		13,691.40	770,280.46
Furniture and equipment		$ 49,487.42	
Less allowance for depreciation		2,796.58	46,690.84
			$1,495,513.10

Liabilities and net worth

Accounts payable			$ 112,098.36
Unexpended balances of grants			
High-school libraries		$ 28,406.27	
Science teaching improvement program		58,153.05	
Conference on mathematics instruction		4,240.55	
Regional consultants on science and mathematics teaching program		10,267.50	101,067.37
Deferred income			
Prepaid dues		$239,202.43	
Prepaid subscriptions		61,665.32	300,867.75
Mortgage payable			167,503.46
Reserve fund			250,000.00
Unallocated funds			
Balance 1 Jan. 1956		$368,853.83	
Add: Excess of revenue over expenditures	$ 1,227.96		
Building fund	193,894.37	195,122.33	
Balance 31 Dec. 1956			563.976.16
			$1,495,513.10

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE CURRENT FUND
STATEMENT OF REVENUE AND EXPENDITURES FOR THE YEAR ENDED 31 DEC. 1956

Revenue			
Dues			$306,003.52
Journals			
Subscriptions			
From investment account (life, 50-year and emeritus members)	$ 3,568.50		
Members special subscriptions	22,237.15		
Nonmember subscriptions	66,065.03	$ 91,870.68	
Advertising		214,883.28	
Miscellaneous sales		2,466.96	309,220.92
Publications			
Binders		$ 1,050.52	
Symposium volumes		21,015.22	22,065.74
New York meeting and exposition			41,906.31
Income from investments			8,489.56
Rental income			11,350.65
Miscellaneous			20,197.11
			$719,233.81
Expenditures			
Administrative and general expense		$ 45,766.36	
Business office		76,183.92	
Building expenses		33,387.65	
Rental of temporary offices		7,613.00	
Depreciation—building and equipment		16,487.98	
Board of directors		6,537.61	
Other committees		4,561.04	
Allowance to divisions		7,772.00	
Section expense		5,303.69	
Circularization—new members		9,109.51	
Annual meeting and exposition		39,267.00	
Journals		439,094.08	
Publications		22,377.40	
Miscellaneous		4,544.61	718,005.85
Excess of revenue over expenditures			$ 1,227.96

Washington 5, D.C., 25 June 1957

To the Council of the
American Association for the
Advancement of Science
Washington, D.C.

We have examined the balance sheet of the Investment Account of the American Association for the Advancement of Science as at 31 Dec. 1956, and the statement of cash receipts and disbursements for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as are considered necessary in the circumstances.

In our opinion, the accompanying financial statements present fairly the financial position of the Investment Account of the American Association for the Advancement of Science as at 31 Dec. 1956, and the cash receipts and disbursements for the year then ended.

G. P. GRAHAM & COMPANY
By G. R. BOWERS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE INVESTMENT ACCOUNT
BALANCE SHEET AS AT 31 DEC. 1956

Assets

Cash in bank		$ 12,542,26
Securities—at cost		412,323.50
		$424,865.76

Liabilities and Reserves

Liabilities		
Academy grants	$ 3,185.01	
Special academy grants	125.00	$ 3,310.01
Endowment funds		
For research	$179,778.85	
For general purposes	173,618.80	
For special purposes	68,158.10	421,555.75
		$424,865.76

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE INVESTMENT ACCOUNT
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS FOR THE YEAR ENDED 31 DEC. 1956

Cash balance 1 Jan. 1956		$ 16,334.46
Receipts		
Income from investments	$ 23,766.29	
Redemption and sale of securities	99,884.24	
Life membership fees	3,788.50	
Gifts	11,811.04	
Special academy grants	400.00	
Deceased emeritus life membership fees	1,100.00	140,750.07
		$157,084.53
Disbursements		
Accounts payable	$ 62.00	
Income allocated to Gordon Research Conferences	1,624.47	
Transfer to Gordon Research Conferences	10,000.00	
Securities purchased	119,704.92	
Newcomb Cleveland prize	1,000.00	
Socio-psychological prize and expense	1,016.41	
Academy grants	3,621.00	
Special academy grants	750.00	
Emeritus life membership fees (from Jane M. Smith fund)	300.00	
Deceased emeritus life membership fees (to Jane M. Smith fund)	1,100.00	
Journal subscriptions (life, 50-year, and emeritus members)	3,568.50	
Expenses	1,794.97	144,542.27
Cash balance 31 Dec. 1956		$ 12,542.26

Heart Association

The American Heart Association's 30th Scientific Sessions, to be held in Chicago, Ill., 25–28 Oct., will commemorate the 300th anniversary of the death of William Harvey, the English scientist who discovered the circulation of blood. The sessions, at which scientists and physicians will report on the most recent advances in knowledge of heart and circulatory diseases, will be part of the association's 33rd annual meeting, which will extent through 29 Oct. Among the groups taking part in the presentation of papers and panels at the scientific sessions will be the association's councils and sections specializing in basic science, circulation, clinical cardiology, cardiovascular surgery, high blood pressure research, rheumatic fever and congenital heart disease, and community service and education.

The national delegate body of the association, the assembly, will be in full session on 29 Oct. to review recommendations made by assembly panels and to elect the officers of the association and members of the board of directors. Meeting concurrently with the scientific sessions will be the annual Staff Conference of Heart Associations, at which staff members of many of the association's 57 affiliates and 350 chapters will discuss programs concerned with community services, school health, professional education, fund raising, and other problems.

International Conference on Peaceful Uses of Atomic Energy

The Secretary-General of the United Nations, Dag Hammarskjold, has announced the provisional agenda for the second International Conference on the Peaceful Uses of Atomic Energy, which will be held in Geneva 1–13 Sept. 1958. Plans for this conference have been made by the Secretary-General and an advisory committee that is composed of representatives from Brazil, Canada, France, India, the U.S.S.R., the United Kingdom, and the United States.

The provisional agenda provides for a series of general sessions on subjects including the future of nuclear power, experience with nuclear power plants, use of nuclear energy for purposes other than production of electricity (for example, marine propulsion), the possibility of developing thermonuclear power (by fusion instead of fission), progress in the use of radioactive isotopes, and health and safety aspects of nuclear power programs. In addition, four series of technical sessions will be held on specific problems involved in atomic energy programs.

Titles and abstracts of papers to be presented at the conference are to be submitted by *1 Mar. 1958* and the full texts by *1 June 1958*.

Forthcoming Events

October

13–18. American Acad. of Ophthalmology and Otolaryngology, annual, Chicago, Ill. (W. L. Benedict, 100 First Avenue Bldg., Rochester, Minn.)

14–16. Association of Official Agricultural Chemists, 71st annual, Washington, D.C. (W. Horwitz, Box 540, Benjamin Franklin Station, Washington 4.)

14–18. American College of Surgeons, 43rd annual clinical cong., Atlantic City, N.J. (ACS, 40 E. Erie St., Chicago 11, Ill.)

14–18. American Soc. of Civil Engineers, New York, N.Y. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

14–18. International Industrial Development Conf., San Francisco, Calif. (E. S. Prentice, Stanford Research Inst., Menlo Park, Calif.)

16–23. Enzyme Chemistry, internatl. symp., Tokyo and Kyoto, Japan. (Inter-

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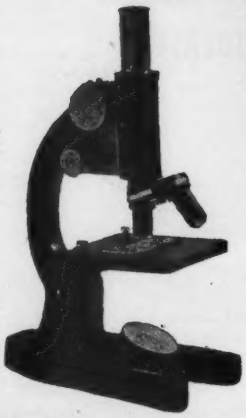

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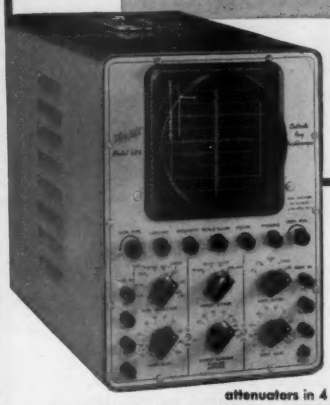

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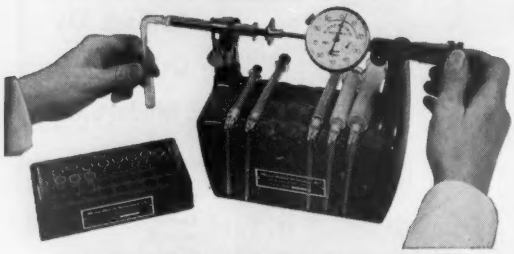

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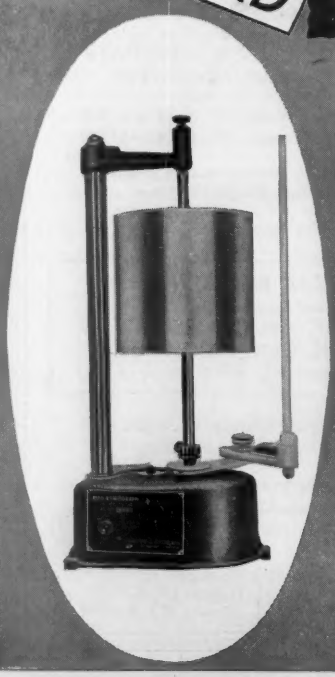

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national Symp. on Enzyme Chemistry, Science Council of Japan, Ueno Park, Tokyo.)

17–18. American Ceramic Soc., 10th Pacific Coast mtg., San Francisco, Calif. (C. E. Pearce, ACS, 4055 N. High St., Columbus 14, Ohio.)

17–18. Industrial Hydraulics, natl. conf., Chicago, Ill. (Conference Secretary, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

17–19. Indiana Acad. of Science, Greencastle. (H. Crull, Dept. of Mathematics, Butler Univ., Indianapolis 7, Ind.)

17–19. Optical Soc. of America, Columbus, Ohio. (S. S. Ballard, Visibility Lab., Scripps Institution of Oceanography, San Diego 52, Calif.)

18–19. National Soc. of Professional Engineers, Bismark, N.D. (P. H. Robbins, 2029 K St., NW, Washington 6.)

19. American Acad. of Psychotherapists, 2nd annual, New York. (G. Dolger, 11 Riverside Dr., New York 23.)

19–26. Social Work, 3rd Pan American cong., San Juan, Puerto Rico. (A. Porrata Dorla, Apartado 3271, San Juan.)

20–22. American College of Apothecaries, St. Louis, Mo. (R. E. Abrams, Hamilton Court, Chestnut and 39 St., Philadelphia, Pa.)

20–27. International Soc. of Surgery, 17th cong., Mexico, D.F., Mexico. (P. Martin, ISS, 141, rue Bellieard, Brussels, Belgium.)

21. Air Pollution Symp., 2nd annual, Philadelphia, Pa. (A. D. Hollingsworth, Franklin Inst., Benjamin Franklin Parkway at 20th, Philadelphia 3.)

21–25. Medical Aspects of Workmen's Compensation, New York. (Office of Associate Dean, New York Univ. Post-Graduate Medical School, 550 First Ave., New York 16.)

21–26. Ultra High Frequency Circuits and Antennas, internatl. conf., Paris, France. (Congrès Circuits et Antennes Hyperfréquences, Société des Radioélectriciens, 10, Avenue Pierre-Larousse, Malakoff (Seine), France.)

22. American Soc. of Safety Engineers, annual, Chicago, Ill. (J. B. Johnson, ASSE, 425 N. Michigan Ave., Chicago 11.)

22–25. American Dietetic Assoc., annual, Miami, Fla. (Miss R. M. Yakel, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

23–25. American Soc. of Body Engineers, Detroit, Mich. (E. W. Lange, ASBE, 100 Farnsworth, Detroit 2.)

24–25. Computer Applications Symp., Chicago, Ill. (Conference Secretary, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

24–25. Engineers General Assembly, New York, N.Y. (Engineers Joint Council, 29 W. 39 St., New York 18.)

24–25. New Mexico Acad. of Science, annual, Albuquerque. (W. J. Koster, Dept. of Biology, Univ. of New Mexico, Albuquerque.)

24–26. Acoustical Soc. of America, Ann Arbor, Mich. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

24–27. American Soc. for Aesthetics, annual, Washington, D.C. (T. Munro, Cleveland Museum of Art, Cleveland 6, Ohio.)

24–5. Pan Indian Ocean Science Assoc., 3rd cong., Tananarive, Madagascar. (R. Paulian, Institut de Recherche Scientifique, B.P. 434, Tananarive.)

25–26. Kentucky Acad. of Science, Berea. (G. Levey, Berea College, Berea.)

25–26. Midwest Conf. on Biology Teaching in Colleges and Smaller Universities, Des Moines, Iowa, (L. P. Johnson, Dept. of Biology, Drake Univ., Des Moines 11.)

25–28. American Heart Assoc. Scientific Sessions, Chicago, Ill. (Medical Director, AHA, 44 E. 23 St., New York 10.)

26. American Mathematical Soc., Washington, D.C. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

27–1. Atom Fair, New York, N.Y. (Atomic Industrial Forum, 3. E. 54 St., New York 22.)

28–30. Association of Military Surgeons of the U.S., annual, Washington, D.C. (R. E. Bitner, AMSUS, Suite 718, 1726 Eye St., Washington 6.)

28–31. American Nuclear Soc., 2nd winter, New York, N.Y. (J. Burt, J. M. Mathes, Inc., 260 Madison Ave., New York 16.)

29–31. Entomological Soc. of Canada, annual, Lethbridge, Alta., Canada. (R. H. Wigmore, Science Service Bldg., Carling Ave., Ottawa 3, Ont.)

29–3. Photoperiodism in Plants and Animals, internatl. conf., Gatlinburg, Tenn. (R. Winthrow, Division of Radiation and Organisms, Smithsonian Inst., Washington 25, D.C.)

30–2. American Soc. of Parasitologists, annual, Philadelphia, Pa. (P. E. Thompson, Research Div., Parke, Davis & Co., Detroit 32, Mich.)

30–2. American Soc. of Tropical Medicine and Hygiene, annual, Philadelphia, Pa. (R. B. Hill, 3575 St. Gaudens Rd., Miami 33, Fla.)

30–2. Federation of Paint and Varnish Production Clubs, 35th annual, Philadelphia, Pa. (FPVPC, 121 S. Broad St., Philadelphia 7.)

31. Reactor Safety Conf., New York, N.Y. (Atomic Industrial Forum, 3 E. 54 St., New York 22.)

31–2. Engineering and Scientific Education Conf., Chicago, Ill. (J. E. Harrington, Western Soc. of Engineers, 84 E. Randolph St., Chicago 1.)

31–2. Gerontological Soc., annual, Cleveland, Ohio. (N. W. Shock, Baltimore City Hospitals, Baltimore 24, Md.)

November

2–8. World Metallurgical Cong., 2nd, Chicago, Ill. (W. H. Eisenman, American Soc. for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.)

2–10. Measuring Instruments and Automation, internatl. cong., Düsseldorf, Germany. (Nordwest Deutsche Ausstellungs Gesellschaft, M.B.H., Ehrenhof 4, Düsseldorf.)

3. American College of Dentists, annual, Miami, Fla. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis 8, Mo.)

3. Society of Vertebrate Paleontology, annual, Philadelphia, Pa. (J. T. Gregory,

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3–9. Pan American Cong. of Pharmacy and Biochemistry, 4th, Washington, D.C. (G. Griffenhagen, Smithsonian Institution, Washington 25.)

4–5. Crystal Structure Analysis by IBM 704 Computer, NBS Conf., Washington, D.C. (V. Vand, Pennsylvania State Univ., University Park.)

4–5. Society of Vertebrate Paleontology, technical sessions, Atlantic City, N.J. (J. T. Gregory, Peabody Museum, Yale Univ., New Haven, Conn.)

4–6. Analytical Chemistry in Nuclear Reactor Technology, Gatlinburg, Tenn. (D. D. Cowen, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tenn.)

4–6. Geological Soc. of America, annual, Atlantic City, N.J. (H. R. Aldrich, GSA, 419 W. 117 St., New York 27.)

4–6. Mineralogical Soc. of America, annual, Atlantic City, N.J. (C. S. Hurlbut, Jr., Dept. of Mineralogy, Harvard Univ., Cambridge 38, Mass.)

4–6. Paleontological Soc., annual, Atlantic City, N.J. (H. B. Whittington, Museum of Comparative Zoology, Harvard Univ., Cambridge 38, Mass.)

4–6. Society of Economic Geologists, annual, Atlantic City, N.J. (H. M. Bannerman, U.S. Geological Survey, Washington 25.)

4–7. American Dental Assoc., annual, Miami, Fla. (H. Hillenbrand, 222 E. Superior St., Chicago 11, Ill.)

6–8. Electrical Techniques in Medicine and Biology, Boston, Mass. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

7–8. Society for Applied Spectroscopy, 12th annual, New York, N.Y. (J. Hansen, 27 Tulsa Ave., Metuchen, N.J.)

7–8. Television and Radio in the Health Field, conf., Chicago, Ill. (American Medical Assoc., 535 N. Dearborn St., Chicago 10.)

7–9. Animal Care Panel, 8th annual, San Francisco, Calif. (R. J. Flynn, ACP, Box 299, Lemont, Ill.)

7–9. Society of Rheology, annual, Princeton, N.J. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York.)

10–13. Society of American Foresters, 57th annual, Syracuse, N.Y. (H. Clepper, SAF, 415 Mills Bldg., Washington 6.)

10–13. Xi Sigma Pi, Syracuse, N.Y. (J. R. Parker, School of Forestry, Univ. of Georgia, Athens.)

10–14. Society of Exploration Geophysicists, 27th annual, Dallas, Tex. (J. C. Hollister, Colorado School of Mines, Golden.)

11–13. Radio Fall Meeting, IRE, Toronto, Ont., Canada. (V. Graham, RETMA, 11 W. 42 St., New York 26.)

11–14. American Petroleum Inst., 37th annual, Chicago, Ill. (API, 50 W. 50 St., New York 20.)

11–15. American Public Health Assoc., 85th annual, Cleveland, Ohio. (R. M. Atwater, APHA, 1790 Broadway, New York 19.)

11–15. American Soc. of Professional Biologists, annual, with American Public Health Assoc., Cleveland, Ohio. (A. F. Borg, Dept. of Bacteriology, Kansas State College, Manhattan.)

(See issue of 16 August for comprehensive list)

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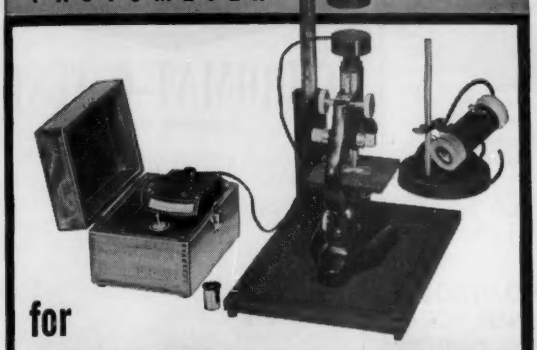

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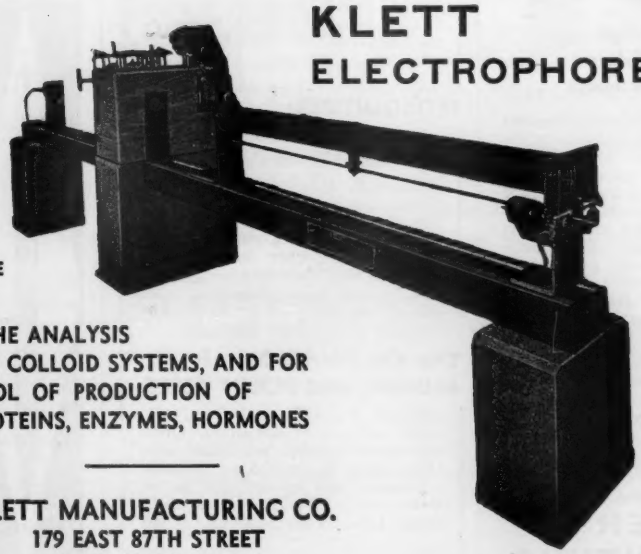

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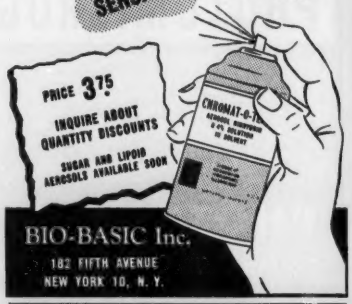

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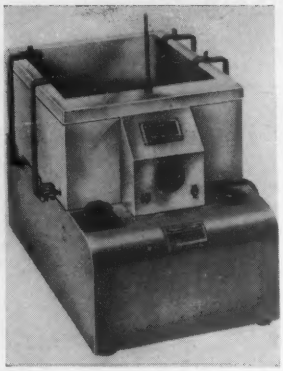

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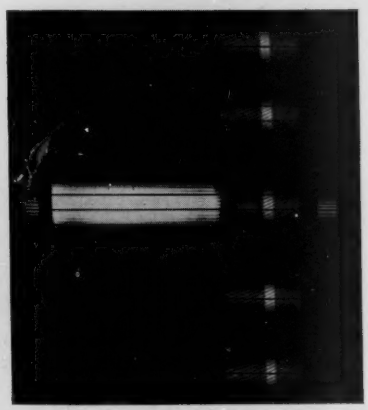

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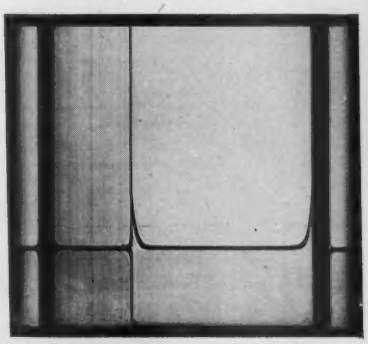
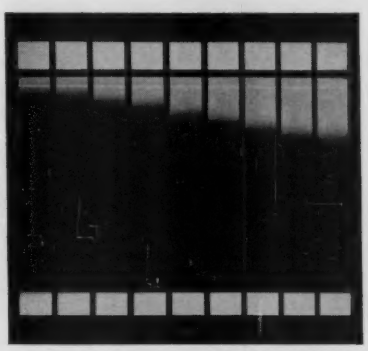
New theoretical developments permit direct measurement of weight-average-molecular weights in polydisperse systems ("Direct Ultracentrifuge Molecular Weights of Synthetic High Polymers," Kegeles, Klainer and Salem, presented at 31st National Colloid Symposium, New York, June 27-29, 1957).



CONCENTRATION IS MEASURED early in low-speed run at meniscus and outer cell edge, and weight average calculated directly.

Petroleum

Both "Preparative" and "Analytical" Spinco Ultracentrifuges have been found to offer new information in studying crude oils and petroleum fractions ("A Study of the Colloidal Characteristics of Petroleum Using the Ultracentrifuge," Ray, Witherspoon and Grim, presented at 31st National Colloid Symposium, New York, June 27-29, 1957).



ABSORPTION PATTERNS showing sedimentation of petroleum dispersed in benzene.

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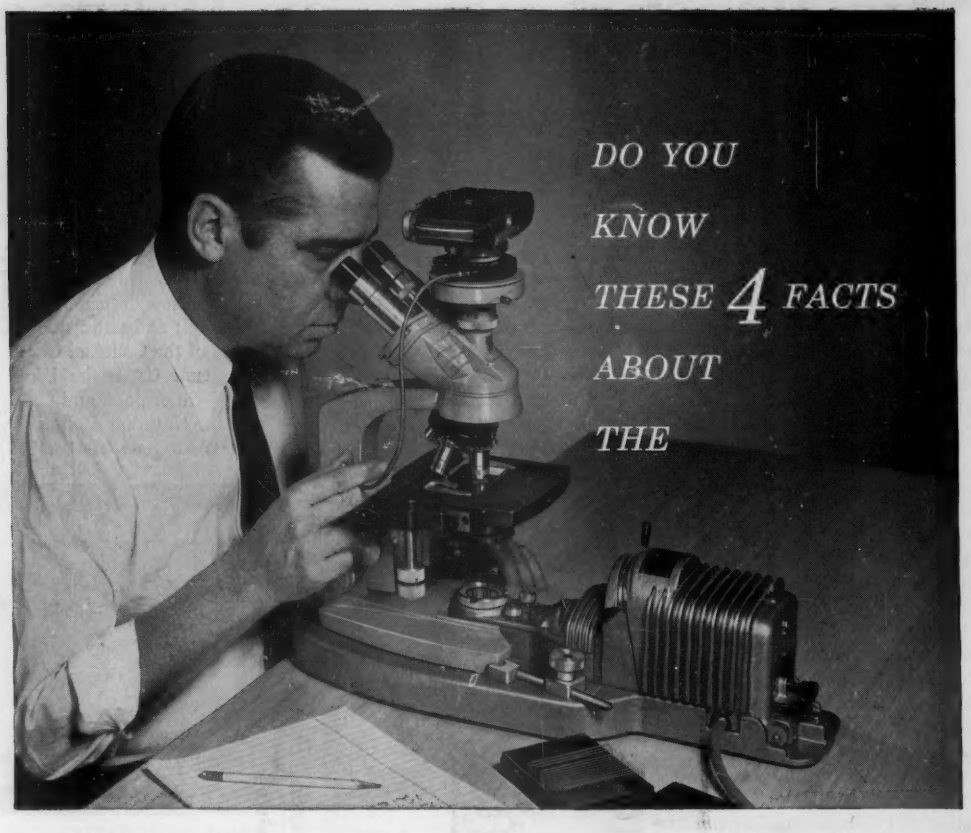

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